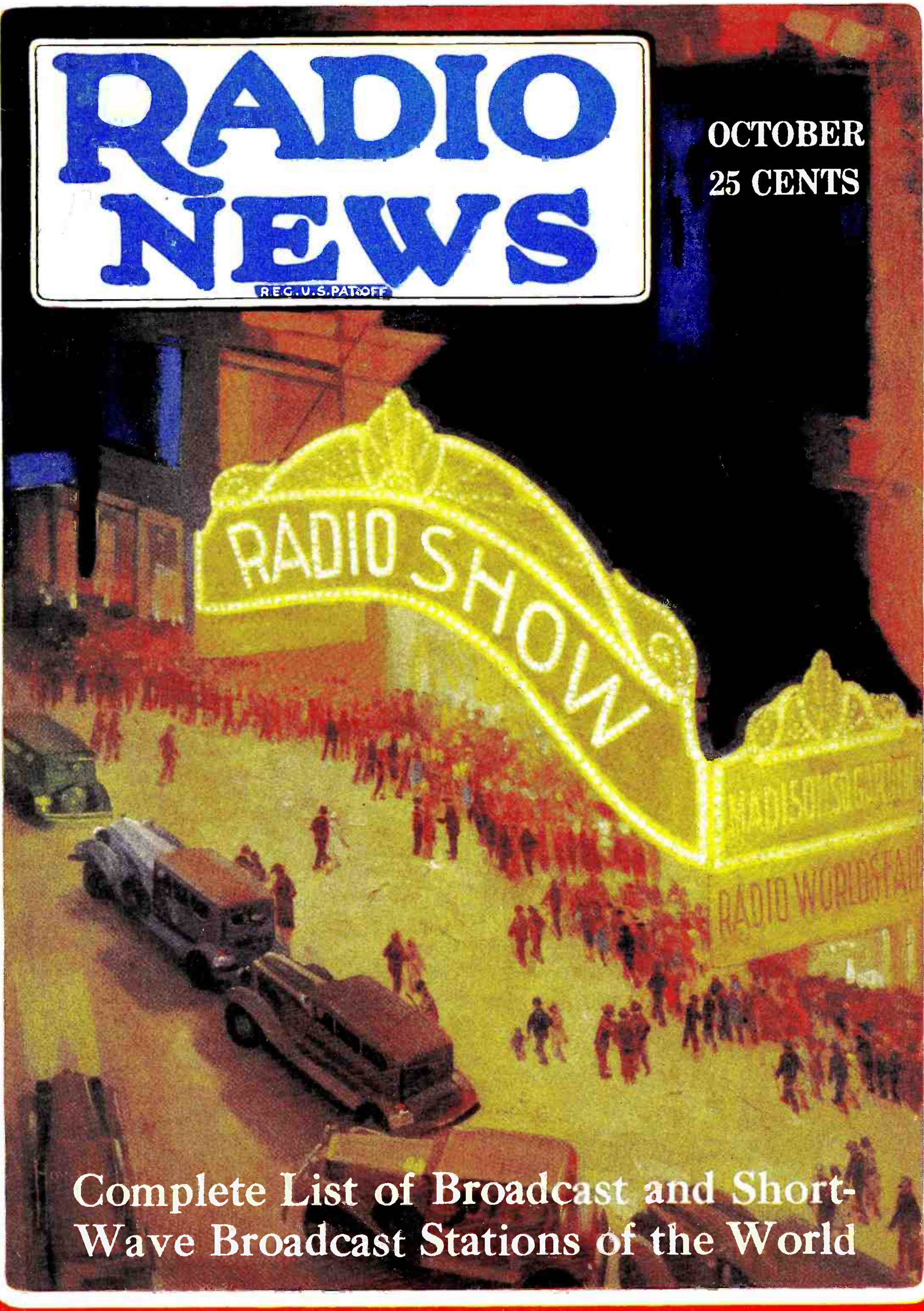
RADIO'S GREATEST MAGAZINE

RADIO NEWS

REG. U.S. PAT. OFF.

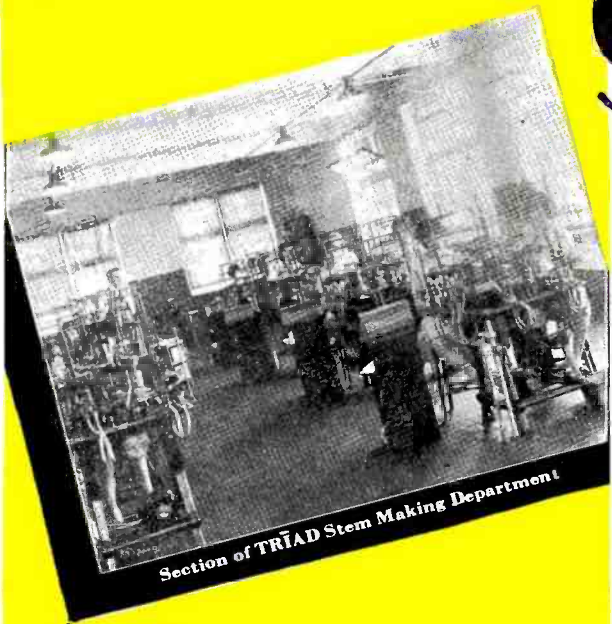
OCTOBER

25 CENTS



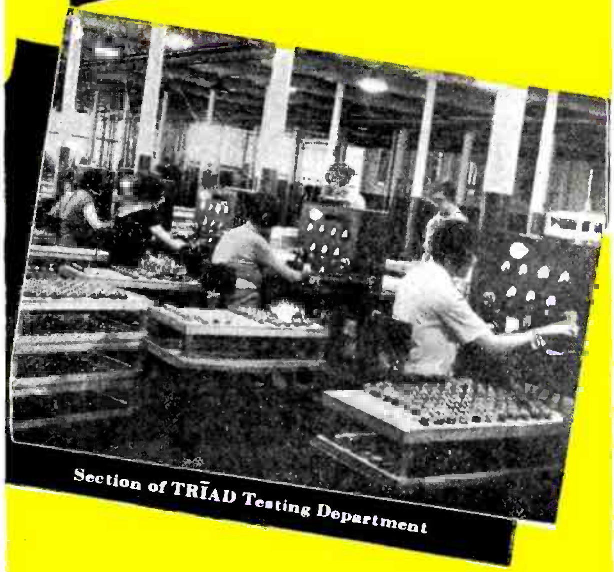
Complete List of Broadcast and Short-Wave Broadcast Stations of the World

9 Final Tests . . . to assure *perfection*



Section of TRĪAD Stem Making Department

Naturally — every TRĪAD Tube is constantly, rigorously tested throughout the entire manufacturing process — a special test follows every individual operation. Yet TRĪAD does *more than that!* When completed, each TRĪAD Tube is subjected to nine *additional* and *final* tests for vital characteristics — tests so stringent that nothing short of absolute perfection can survive them! This infinite care in manufacture has won for TRĪADS their reputation for superior quality — and has made possible that guarantee that goes with every TRĪAD Tube—a minimum of six months' satisfactory service or a proper adjustment. You can rely on TRĪADS — the tubes backed by an actual Insurance Certificate!



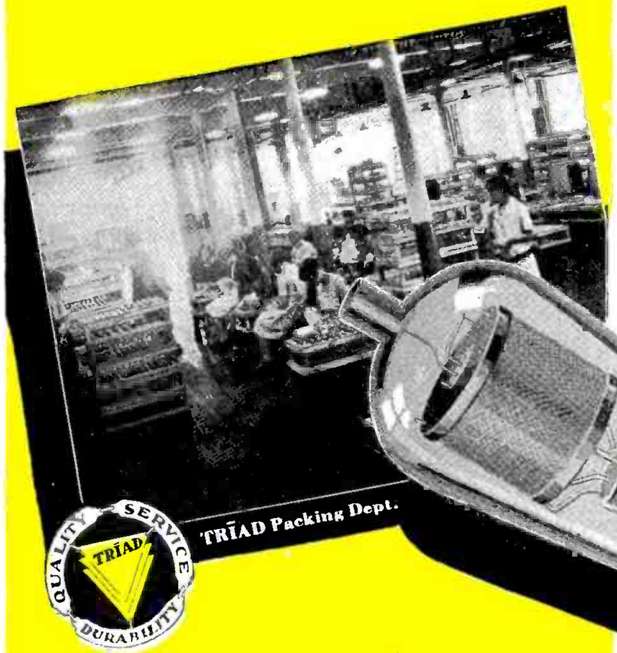
Section of TRĪAD Testing Department

Call your jobber or write us direct for complete TRĪAD *information.*

TRĪAD MFG. CO., Inc., Pawtucket, R. I.

Tune in on the TRĪADORS every FRIDAY evening, 8 to 8:30 Eastern Daylight Time, over WJZ and associated NBC Stations.

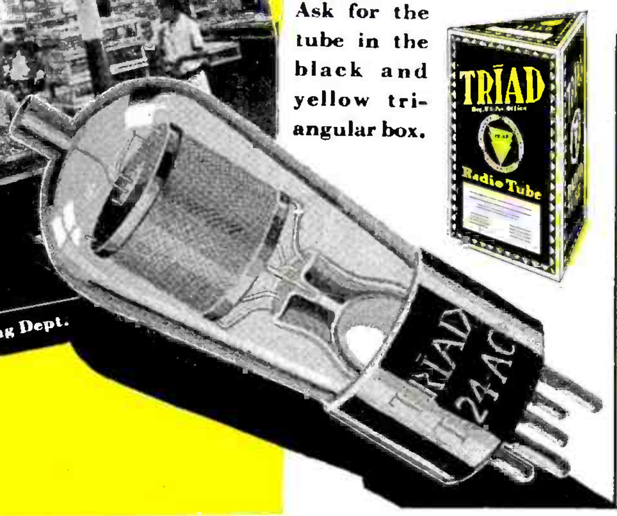
TRĪAD
INSURED
RADIO TUBES



TRĪAD Packing Dept.

QUALITY SERVICE DURABILITY TRIAD

Ask for the tube in the black and yellow triangular box.



9 FINAL TESTS

Below are listed the nine *final* tests for vital characteristics to which every TRĪAD Tube is subjected.

1 Gas
2 Emission
3 Filament Current
4 Plate Current
5 Oscillation
6 Grid Voltage
7 Mutual Conductance
8 Plate Impedance
9 Amplification Constant

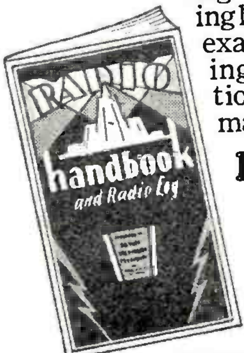
4 of the 40 Easy Ways to Make $3.00 an Hour In Your Spare Time in RADIO

THE four plans shown are but a sample of the many ways in which our members are making $3.00 an hour upwards, spare time and full time, *from the day they join the Association.* If you want to get into Radio, have a business of your own, make $50 to $75 weekly in your spare time, investigate the opportunities offered the inexperienced, ambitious man by the Association.

Our Members Earning Thousands of Dollars Every Week

The Association assists men to cash in on Radio. It makes past experience unnecessary. As a member of the Association you are trained in a quick, easy, practical way to install, service, repair, build and rebuild sets—given sure-fire money-making plans developed by us—helped to secure a position by our Employment Department. You earn while you learn, while you prepare yourself for a big-pay Radio position.

The Association will enable you to buy parts at wholesale, start in business without capital, help you get your share of the $600,000,000 spent annually for Radio. As a result of the Association, men all over the country are opening stores, increasing their pay, passing licensed operator examinations, landing big-pay positions with Radio makers.



Mail Coupon Today for the FREE HANDBOOK

It is not only chock-full of absorbing information about Radio, but it shows you how easily you can increase your income in your spare time. Mailing the coupon can mean $50 to $75 a week more for you.

Radio Training Association of America
4513 Ravenswood Avenue Dept. RN-10, Chicago, Illinois

Below are a few of the reports from those now cashing in on the "40 Easy Ways"

Clears $3,000.00 Frank J. Deutch, Pa. — "Since joining the Association I have cleared nearly $2,000.00. It is almost impossible for a young fellow to fail, no matter how little education he has, if he will follow your easy ways of making money."

$1,100.00 in 6 Weeks J. R. Allen, Calif. — "Have done over $1,100.00 worth of business in the last 6 weeks. Next month I am going to open up a store of my own. I never knew that money could come so fast and easy."

$25.00 a Week Spare Time N. J. Friedrich, N. Y.—"I have averaged $25.00 a week for the last 7 months even though I am not a graduate but just learning."

Training Lands Him Job R. C. Kirk, N. C.—"Your training has been very valuable to me. I landed a job with the big department store out here a few weeks ago because I had my membership card with me. There were a large bunch of applications ahead of me."

ACT NOW
If You Wish NO-COST Membership

For a limited time we will give to the ambitious man a No-Cost Membership which need not—should not—cost you a cent. For the sake of making more money now, and having a better position in the future, mail coupon below *now.* You'll always be glad you did.

Radio Training Association of America
Dept. RN-10, 4513 Ravenswood Ave., Chicago, Ill.

Gentlemen: Please send me by return mail full details of your Special No-Cost Membership Plan, and also a copy of your Radio Handbook.

Name ______________________

Address ______________________

City ______________ State ______________

Radio News

Volume XI. CONTENTS FOR OCTOBER, 1929 No. 4

(*Advertisers' Index on page* 380)

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Member: Audit Bureau of Circulations

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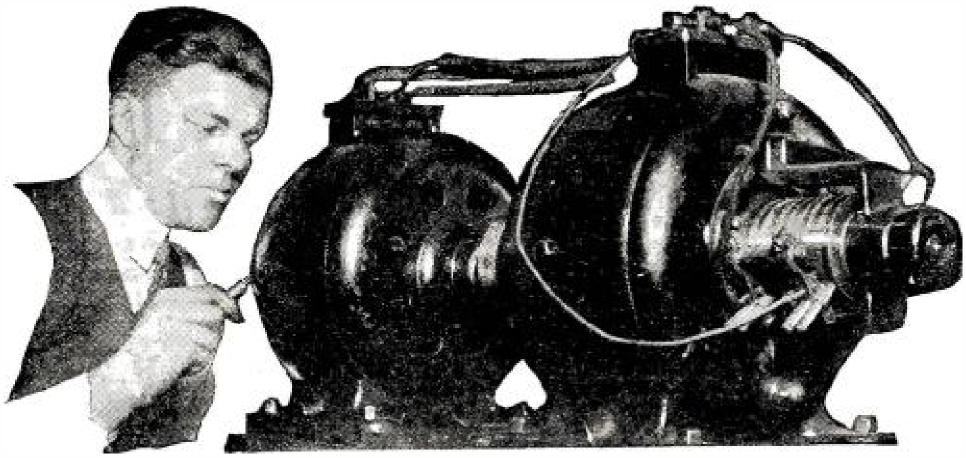
EDWARD LANGER PRINTING CO., INC., JAMAICA, N. Y.



Amazingly Easy Way to get into ELECTRICITY

Don't spend your life waiting for $5.00 raises in a dull, hopeless job. Now . . . and forever . . . say good-bye to 25 and 35 dollars a week. Let me show you how to qualify for jobs leading to salaries of $50, $60 and up, a week, in Electricity—NOT by correspondence, but by an amazing way to teach, that makes you a practical expert in 90 days! Getting into Electricity is far easier than you imagine! Act now, today!

Learn Without Books in 90 DAYS

LACK of experience—age or advanced education bar no one. I don't care if you don't know an armature from an air brake—I don't expect you to! I don't care if you're 16 years old or 40—it makes no difference! Don't let lack of money stop you. Most of the men at Coyne have no more money than you have.

Railroad Fare Allowed

I will allow your railroad fare to Chicago, and if you should need part-time work I'll assist you to it. Then, in 12 brief weeks, in the great roaring shops of Coyne, I train you as you never dreamed you could be trained . . . on the greatest outlay of electrical apparatus ever assembled . . . costing hundreds of thousands of dollars . . . real dynamos, engines, power plants, autos, switchboards, transmitting stations . . . everything from doorbells to farm power and lighting . . . full-sized . . . in full operation every day!

No Books--All Actual Work

No books, no baffling charts . . . all real actual work . . . building real batteries . . . winding real armatures, operating real motors, dynamos and generators, wiring houses, etc., etc. That's a glimpse of how we make you a master practical electrician in 90 days, teaching you far more than the average ordinary electrician ever knows and fitting you to step into jobs leading to big pay immediately after graduation. Here, in this world-famous *Parent school* —and nowhere else in the world—can you get such training!

Prepare for Jobs Like These

Here are a few of hundreds of positions open to COYNE-trained men. Our free employment bureau gives you lifetime employment service.

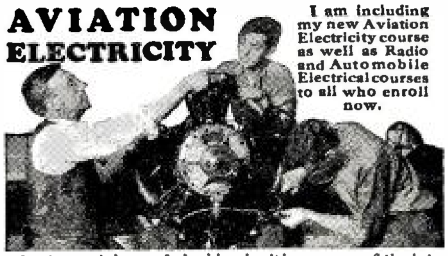
Armature Expert	up to $100 a Week
Substation Operator	up to $65 a Week
Auto Electrician	$60 a Week and up
Inventor	Unlimited
Maintenance Engineer	up to $100 a Week
Service Station Owner	$60 a Week and up
Radio Expert	$60 a Week and up

Jobs, Pay, Future

Don't worry about a job, Coyne training settles the job question for life. Demand for Coyne men often exceeds the supply. Our employment bureau gives you lifetime service. Two weeks after graduation, Clyde F. Hart got a position as electrician with the Great Western Railroad at over $100 a week. That's not unusual. We can point to Coyne men making up to $600 a month. $60 a week is only the beginning of your opportunity. You go into radio, battery or automotive electrical business for yourself and make up to $15,000 a year.

AVIATION ELECTRICITY

I am including my new Aviation Electricity course as well as Radio and Automobile Electrical courses to all who enroll now.

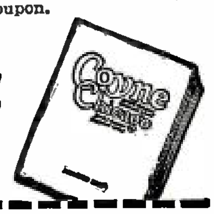


Students wiring and checking ignition on one of the late type Radial Aircraft Engines in our aviation department.

Get the Facts

Coyne is your one great chance to get into electricity. Every obstacle is removed. This school is 30 years old—Coyne training is tested—proven beyond all doubt—endorsed by many large electrical concerns. You can find out everything absolutely free. Simply mail the coupon and let me send you the big, free Coyne book of 150 photographs . . . facts . . . jobs . . . salaries . . . opportunities. Tells you how many earn expenses while training and how we assist our graduates in the field. This does not obligate you. So act at once. Just mail coupon.

Get this FREE Book



Mr. H C. LEWIS, Pres.
COYNE ELECTRICAL SCHOOL Dept. 79-27
500 S. Paulina St., Chicago. Ill.
Dear Mr. Lewis: Without obligation send me your big free catalog and all details of Railroad Fare to Chicago, Free Employment Service, Aviation Electricity and Automotive Electrical Courses and how I can "earn while learning."

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Address..............................

City.............................. *State*..............

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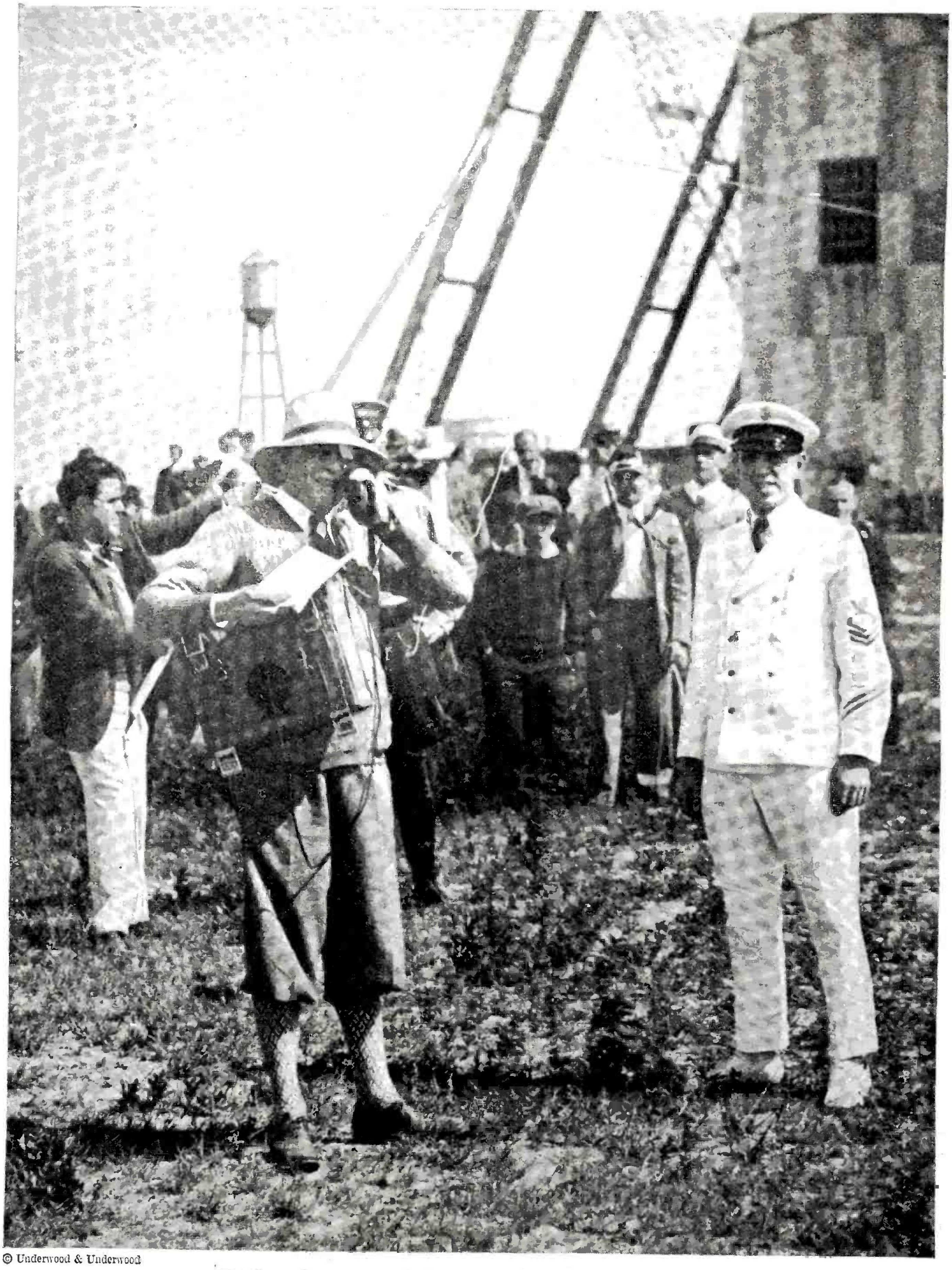
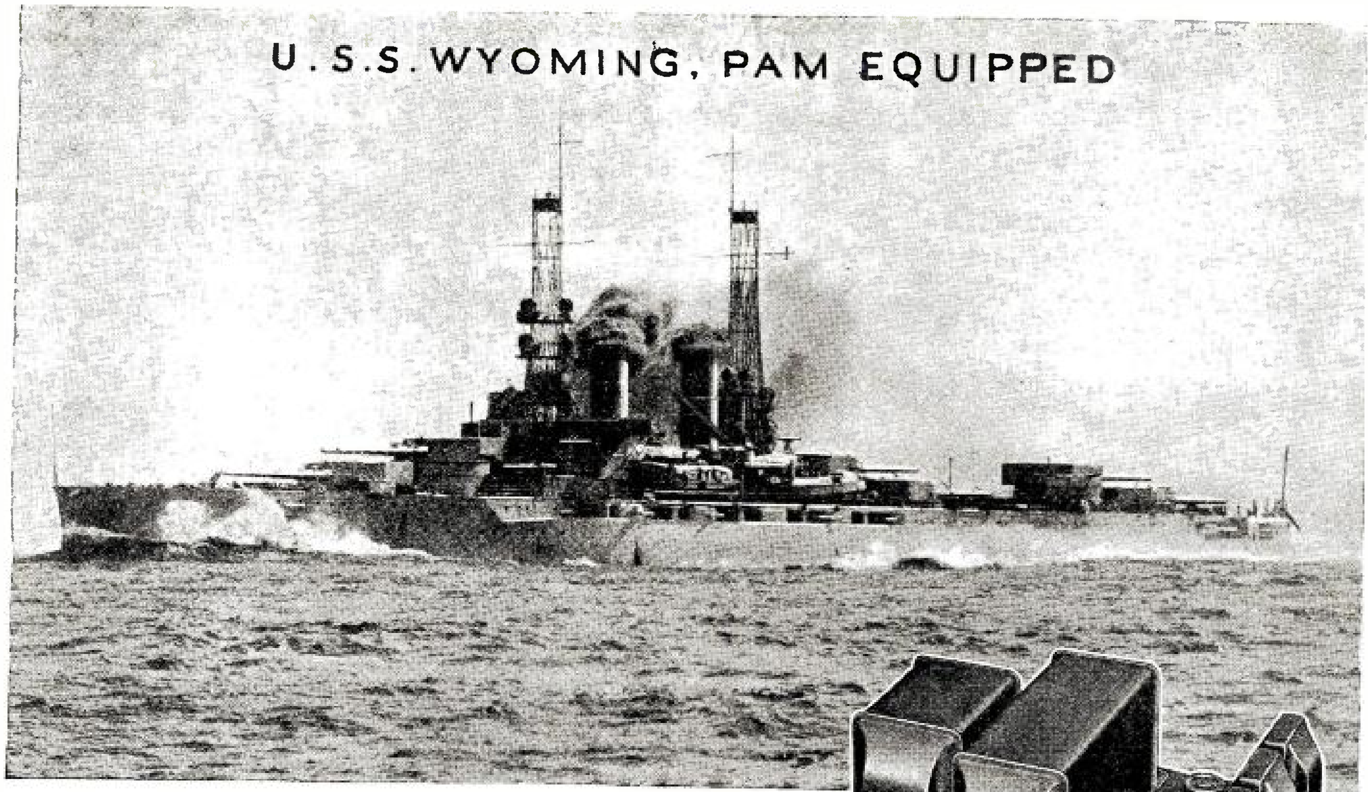


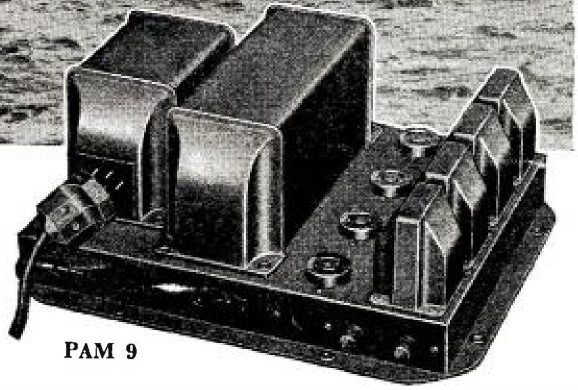
© Underwood & Underwood

Bringing *the* Mountain *to* Mahomet

HERE is Floyd Gibbons, well-known writer, with a portable short-wave transmitter, giving a running account of events in connection with the arrival of the *Graf Zeppelin* at Lakehurst, August 4; his voice being picked up and rebroadcast over a nation-wide hook-up. Two men, with ten-foot poles, carried his antenna system.



PAM



PAM 9

Accompanies the Big Guns

Where important events are staged, in this and many other countries, you will find Samson PAM Amplifiers providing entertainment and instruction through loud-speaker systems.

Not only on battleships, but on coastwise vessels and excursion steamers —probably in your neighborhood— are opportunities for such installations.

Truly these are opportunities for worth-while profits from the sale of PAMS and associated equipment, such as radio sets and loud speakers, phonographs and pick-ups, microphones and wiring.

A new 16-page bulletin giving mechanical and electrical characteristics, representative installations, and many new PAM Amplifiers will be sent upon receipt of 10c in stamps to cover postage. When writing ask for Bulletin No. RN3.

Main Office:
Canton, Mass.

Samson Electric Co.

MEMBER R.M.A.

Manufacturers Since 1882

Factories at Canton and Watertown, Mass.

▶▶▶

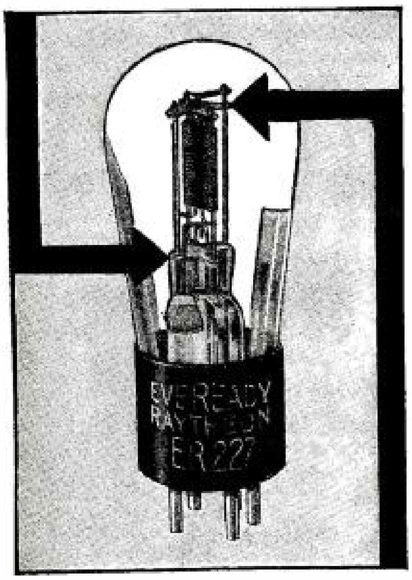
With EVEREADY RAYTHEON 4-PILLAR Tubes, you can get the MOST from your present radio receiver

PEOPLE in all parts of the country are telling of the greater power, increased distance, improved tone, and quick action of these remarkable new tubes. The reason is that Eveready Raytheons are built stronger—immune to the bumps and jolts of shipment and handling. They come to you in as perfect condition as when they leave our laboratory test room.

The Eveready Raytheon 4-*Pillar construction* is exclusive and patented. Examine the illustration at the bottom of this page. See how the elements of this tube are anchored at eight points.

This is of particular importance in tubes of the 280 rectifier and 224 screen-grid type which have heavier elements, and in tubes used for push-pull audio amplification, where uniform characteristics are most essential. Eveready Raytheon 4-*Pillar* Tubes come in all types. At your dealer's. He also has the famous B-H tube for "B" eliminator units.

NATIONAL CARBON CO., INC.
General Offices: New York, N. Y.
Unit of Union Carbide UCC *and Carbon Corporation*



Showing the exclusive, patented Eveready Raytheon 4-Pillar construction. Note the sturdy four-cornered glass stem, the four heavy wire supports, and the bracing by a stiff mica sheet at the top.

Eveready Raytheon Screen-Grid Tube, ER 224. Without Eveready Raytheon's 4-Pillar construction, this type of tube is delicate, liable to severe damage in shipment.

EVEREADY RAYTHEON

Trade-marks

4 SCREEN-GRID TUBES AND POWER-DETECTION!

Screen-Grid Performance

Screen-Grid Tubes have opened the door to an altogether new kind of distance-performance in Radio. The new NATIONAL MB-29 Screen Grid Tuner uses 4 A. C. Screen-Grid tubes.

Why Power Detection?

The latest and biggest improvement in Broadcasting is the use of High-Percentage-Modulation, now employed by the newest and finest stations. Soon all stations of any importance will adopt it, because of the better transmission it permits.

This improvement is not particularly noticeable with receivers using the older forms of detection. But we have just developed a system of Power-Detection especially designed to secure proper reception from stations using High Percentage Modulation and this is now offered for the first time, in the MB-29.

Band-Selector Tuning

Band-selector tuning assures sharp separation between stations, and, at the same time, finest quality of reproduction, because with the "open window" of the tuning curve, side-bands are not cut.

A Magnificent Chassis

With its completely shielded aluminum chassis, precision matched coils and latest NATIONAL Weld-Built Condensers—with its modernist NATIONAL *Projector* Dial—this tuner makes possible the construction of a magnificent A. C. receiver which combines the cleancut finish and appearance of the finest factory-built model with the quality and perfection of a custom-built job.

The Velvetone Amplifier Power Supply

For use with the MB-29 Tuner is the specially designed NATIONAL Velvetone Amplifier, a complete Amplifier-Power Supply, using two UX245's in push-pull and equipped with phonograph jack. This amplifier is licensed under patents of R. C. A. and Associated Companies and is sold fully wired and ready for use (less tubes).

The Tuner
Note the individual Coil Shields and the absolutely cleancut appearance.

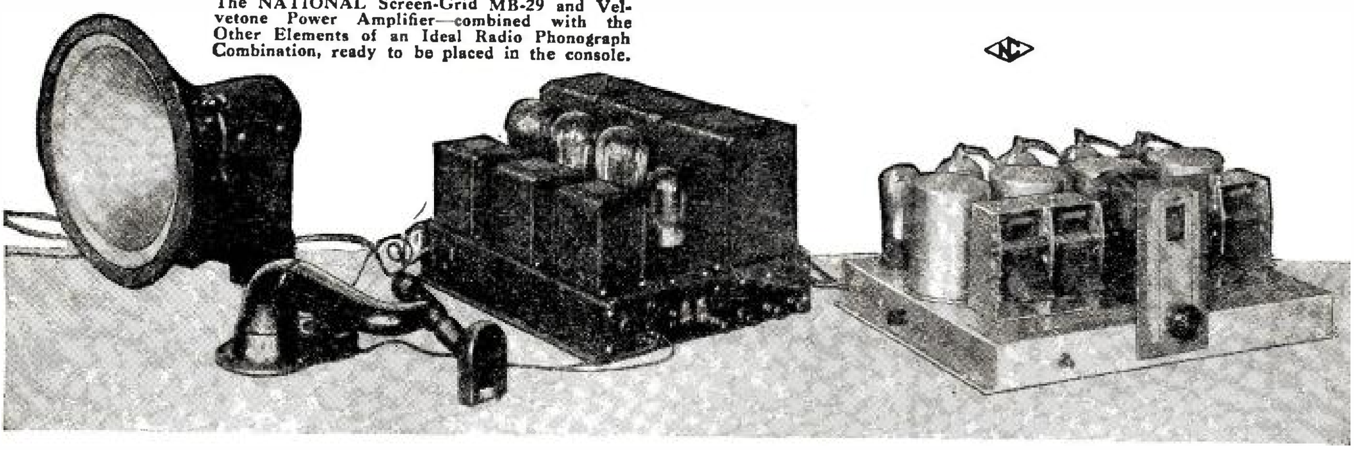
Consoles and Tables for the MB-29

There are available a selection of beautifully finished and specially priced consoles and tables for housing the MB-29 in various popular combinations.

The MB-29 bristles with new and ingenious features for your convenience and pleasure. *Write us today for full information, mentioning Radio News.*

NATIONAL COMPANY, INC.
ENGINEERS & MANUFACTURERS
61 SHERMAN ST., MALDEN, MASS.
EST. 1914 . .W.-A. READY, PRES.

The NATIONAL Screen-Grid MB-29 and Velvetone Power Amplifier—combined with the Other Elements of an Ideal Radio Phonograph Combination, ready to be placed in the console.



NATIONAL « SCREEN-GRID » -- MB-29

Ask Us About It. Write Us Today.

New Handibooks for Every Home

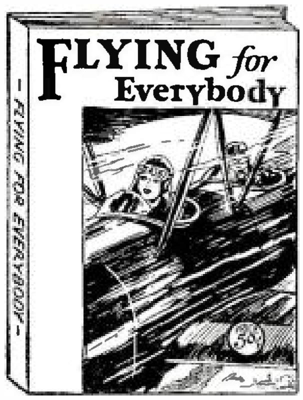
Get Them From Your Newsdealer or Fill Out and Mail Coupon Below

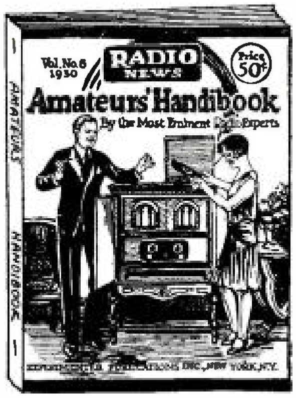
RADIO TROUBLE FINDER 1930 Edition

Ever have your radio fail when a big program was on? That's when the New Radio Trouble Finder is worth its weight in gold! It tells you what to do, and do quickly in order to find and repair the trouble. 64 pages in easy-to-understand language and non-technical diagrams. Every home should own a copy. Price postpaid only **25c**

FLYING FOR EVERYBODY

Everyone interested in aviation should own this most helpful book. Includes the fundamental principles of flying; how to learn to fly; how to tell when a plane is safe; passenger rates on newest air routes, etc. In fact, it might well be called a complete encyclopedia on Aviation. 96 pages, fully illustrated. Printed in the large 9 by 12 inch size, with beautiful colored cover. Price postpaid only **50c**





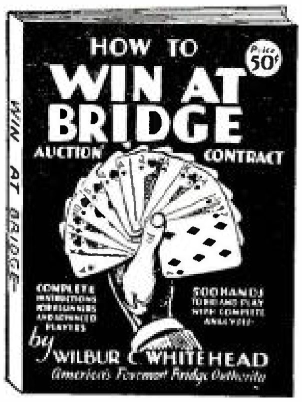
RADIO AMATEUR'S HANDIBOOK 1930 Edition

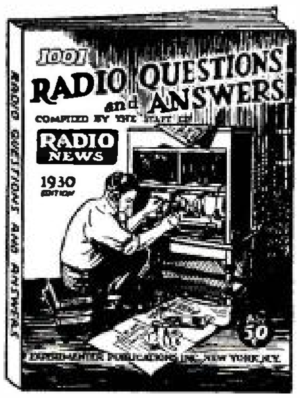
Sometimes called the Radio Amateur's Bible. Includes 10 How-to-Build articles, with complete instructions and diagrams; new radio wrinkles, DX hints, data on the new tubes, answers to AC problems, and helpful, money-saving ideas for the radio service man. 96 illustrated pages. Large 9 by 12 inch size. Beautiful colored cover. Price postpaid **50c**

HOW TO WIN AT BRIDGE

by Wilbur C. Whitehead

The world-famous Bridge authority's newest book. Tells how to play both Auction and Contract Bridge TO WIN! Complete rules of play and methods of scoring for both Auction and Contract Bridge. Contains 500 hands to bid and play, with complete solutions and analyses in back of book. The biggest 50c worth ever offered to Bridge fans. Printed in 2 colors. Hearts and diamonds shown in red throughout.. 96 pages. Large 9 by 12 inch size. Beautiful colored cover. Price postpaid only **50c**



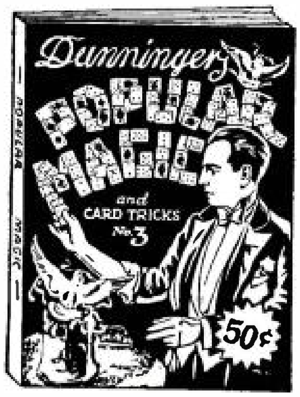


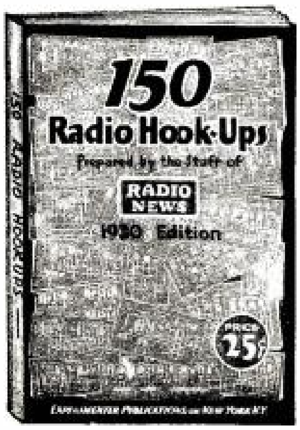
1001 RADIO QUESTIONS AND ANSWERS 1930 Edition

If you own a radio, you need this book. Everything you want to know about radio is in it, from "How to Kill Outside Radio Noises" to a clear description of the newest tubes and how to use them. If you have a question on radio, here is your answer and a thousand more. 96 illustrated pages. Large 9 by 12 inch size. Beautiful colored cover. Price postpaid only **50c**

POPULAR MAGIC AND CARD TRICKS 1930 Edition

Hundreds of parlor tricks and games described and illustrated so that anybody can do them. Always good for an evening's entertainment. Mystify your friends, charm the ladies. 96 pages. Large 9 by 12 inch size. Beautiful colored cover. Price postpaid only **50c**





150 RADIO HOOKUPS 1930 Edition

All the newest hook-ups, described with complete diagrams. Every radio fan and set-builder should own a copy for ready reference. Includes crystal circuits, single circuit detectors, audio and RF amplifier circuits, superheterodynes and numerous AC and DC receiver circuits. 64 pages, with beautiful colored cover. Price postpaid **25c**

We accept stamps for all orders under $1.

Simply Clip and Mail This Coupon With Your Order.

EXPERIMENTER PUBLICATIONS, Inc.
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Gentlemen: I enclose .... (amount here), for which please send me postpaid the following:

Check Ones You Want

- ☐ Radio Trouble Finder
- ☐ Amateur's Handibook
- ☐ 1001 Questions & Ans.
- ☐ 150 Radio Hook-ups
- ☐ Flying for Everybody
- ☐ Popular Magic and Card Tricks
- ☐ How to Win at Bridge

Name..

Street Address..

City.................................State.................

Which make of radio tubes shall I buy? . . .

Dr. Lee De Forest, inventor of the radio tube and the "Father of Radio."

Here are the facts—make the decision for yourself

The right selection of tubes makes an amazing difference in the pleasure you get from radio. Radio tubes may *look* alike but that is where the comparison ends.

The first radio tube was invented by Dr. Lee De Forest, in Chicago, in 1906. Today every radio tube in the country, no matter what its name, is made under the invention and basic patents of Dr. Lee De Forest.

Engineers in his laboratories have made many recent improvements that are included in De Forest Audions. For example, consider vacuum which determines the life of a tube and its tone qualities. De Forest Audions contain less than 1-15th the air pressure of most other radio tubes. That is why they last longer

The objectionable hum and buzz common to most house-current sets are caused by improperly designed tubes. By a new process of insulation De Forest Audions reduce this hum to a point where you can scarcely detect it.

Only by passing the most rigid inspections and tests and maintaining these exacting tolerances are De Forest Audions ready to bear the name of the inventor. That is one reason why they have been regarded as the standard for 23 years.

It is easy for you to convince yourself that De Forest Audions are superior. Just say to your dealer, "I'd like to hear this set with De Forest Audions." It is no more trouble for him than changing electric light bulbs. You will detect the difference instantly.

Give your set a real chance with these perfected radio tubes. The name is plainly stamped on the base.

DE FOREST RADIO CO., JERSEY CITY, N. J.

Branch offices located in

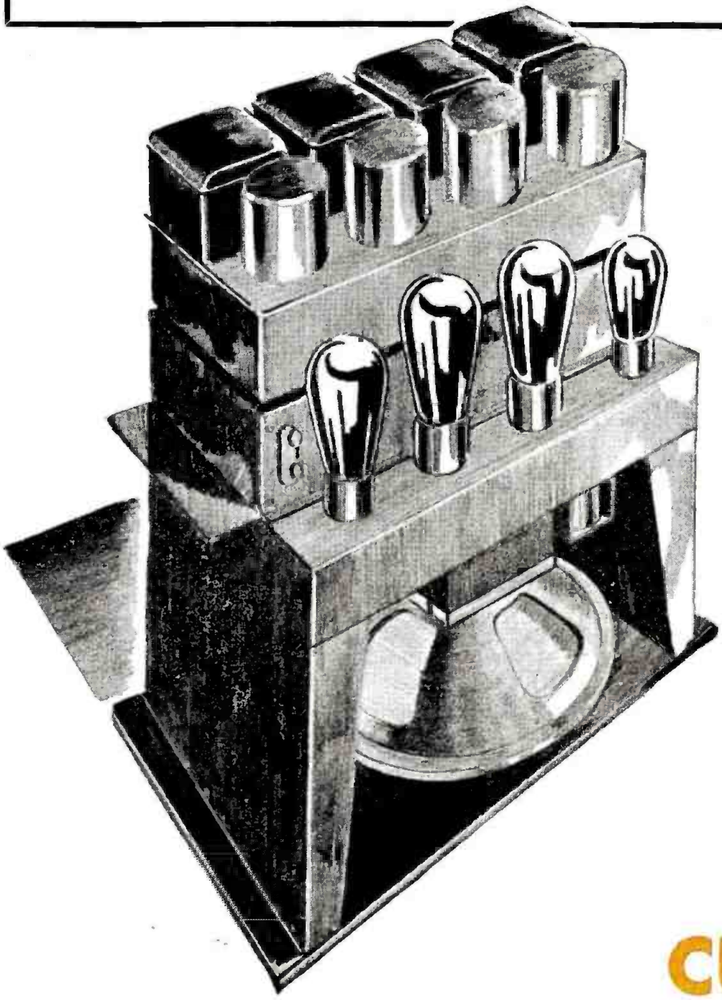
NEW YORK	DALLAS	DETROIT	LOS ANGELES
PHILADELPHIA	ST. LOUIS	MINNEAPOLIS	SEATTLE
BOSTON	PITTSBURGH	DENVER	
ATLANTA	CHICAGO	KANSAS CITY	

de Forest
AUDIONS

To enjoy screen grid at its best insist on De Forest Screen Grid Audion 424.

COLONIAL

4 SCREEN-GRID TUBES



With Dr. Fulton Cutting's SENSATIONAL INVENTION ...the built-in

CUTTING DYNAMIC SPEAKER

DIFFERENT FROM ALL OTHER DYNAMICS

With the greatest acoustical advance in years...

CUTTING SOUND RADIATION

NOW...the proved principle of indirect lighting applied to sound...now a FLOOD of music instead of a concentrated "BEAM"...now *"Radio's Clearest Voice"* recreating EXACTLY conditions at the actual point of broadcast. This is what the engineering genius of Dr. Fulton Cutting has made possible with the new Colonial Radio.

Integral Perfection

Receiver, audio amplifier, current supply and speaker combined in one sturdy power plant. Three stages of screen grid tuned radio frequency amplification and a tuned grid power detector give the utmost in sensitivity—with linear detection. New system of volume control regulates stupendous amplification. These are but a few of the outstanding features of the new Colonial.

The NEW COLONIAL *Radio*

COLONIAL

"RADIO'S CLEAREST VOICE"

Editorial

Radio for Small Pleasure Boats

WHEN we think of yachts and yachting, we naturally think of gaiety and entertainment. The proper use of a radio broadcast receiver aboard a yacht adds greatly to the pleasures of yachting.

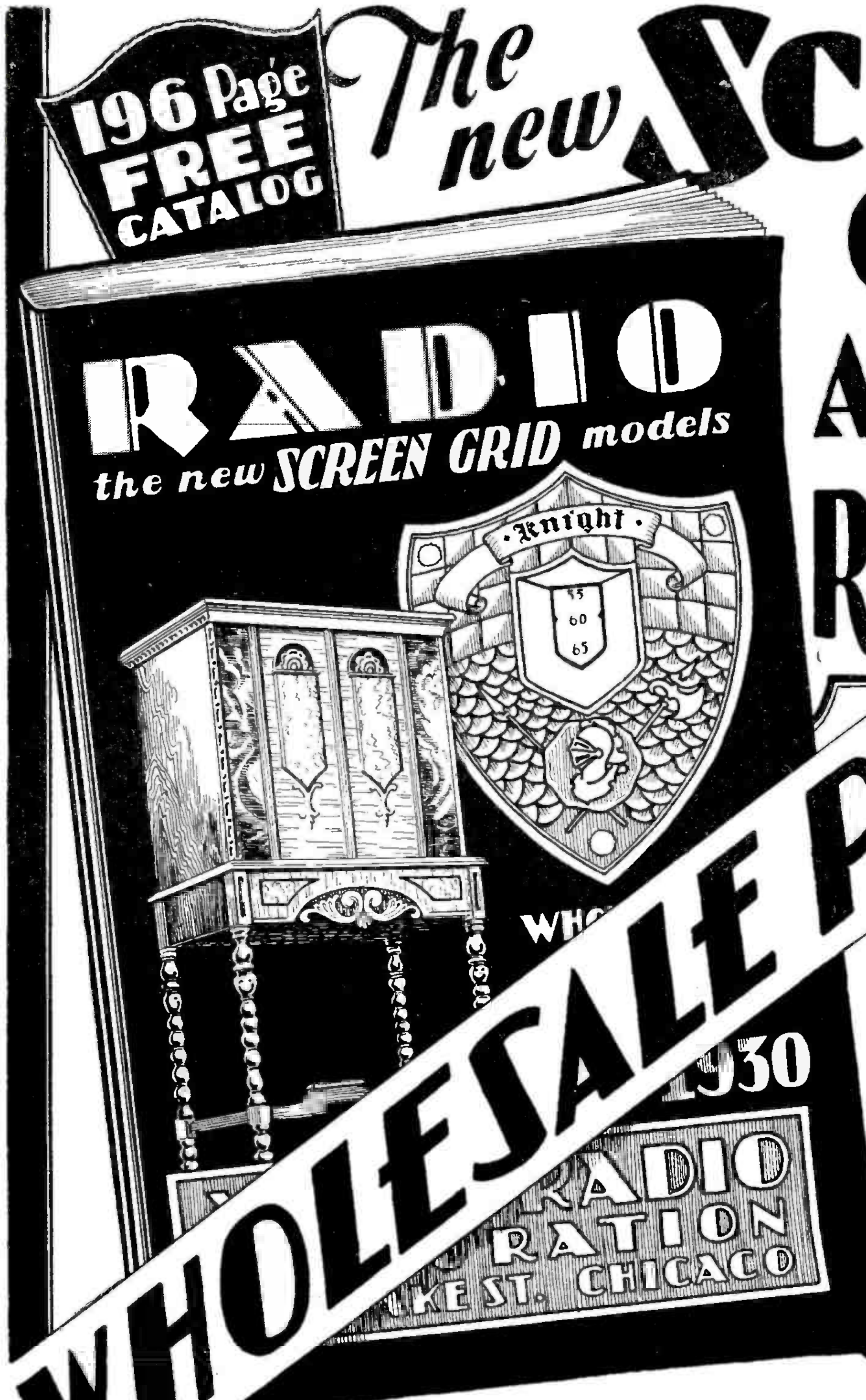
It is our purpose to assist various Yacht Clubs and motor boat manufacturers in the development of an additional radio feature, far more important than the providing of entertainment alone. We contemplate the development of radio receiving equipment suitable for use on small as well as large boats, which may be used for entertainment and navigation purposes as well.

Many small boats are prevented from venturing any great distance from shore because their owners feel that such a venture would lack caution, particularly when there is no one aboard who is familiar with navigation technique. The aviation industry is going to be largely responsible for a growth in deep sea navigation for small craft, because it will be possible for the small-boat owner to guide himself from port to port by picking up radio signals from airplane beacon transmitters, and by a simple process of triangulation determine his location at almost any time.

Work along these lines is well under way, and within a short time a description of the entire system will appear in the pages of this magazine.

Arthur H. Lynch

EDITORIAL DIRECTOR,
MACKINON FLY PUBLICATIONS, INC.



The new SCREEN GRID A-C RECEIVERS

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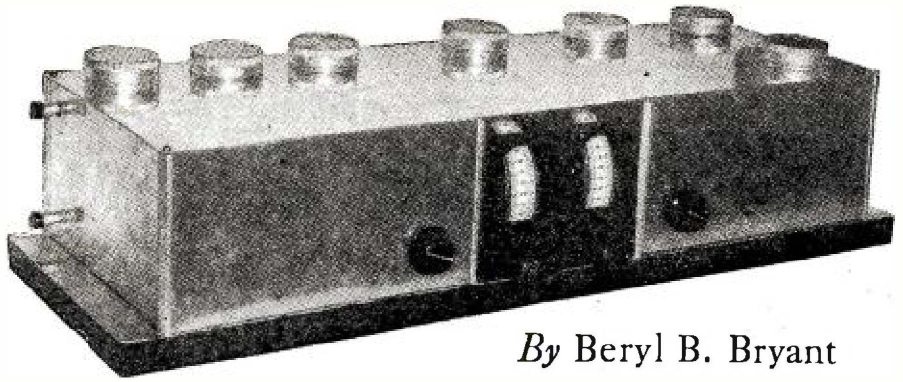
Complete Constructional Details *for Building the A. C. Operated* Seven Tube MAGISTER Tuner



By Beryl B. Bryant

THE writer prefers broadcast reception from stations outside the sphere of the local broadcast area. There are many reasons for this preference.

Consistent reception of distant broadcast stations on the loud speaker requires a powerful receiver. The selectivity must, of course, be in equal proportion to the amplification, yet must not produce distortion by side-band cut-off. To the writer, with the receiver described here, using a not-to-good antenna, medium powered stations located within a radius of three to four hundred miles are considered as locals. If the reader cares to investigate, he will find but very few receivers that are capable of consistent DX reception on the loud speaker, not to mention the lack of super-DX reception. He will not find such receivers to possess a sufficient degree of selectivity without side band cut-off to prevent the interference of locals.

With these things in mind, many trials and experiments were conducted before the final type of circuit and construction design was adopted. In passing, the author might mention that the "Home Builder's Seven," described in the April issue of RADIO NEWS, was the result of one of these experiments. It is remarkable to note the DX qualities of such a simple receiver as compared to the intricate works of receivers having the same qualities for DX. The writer might further mention that the greatest distance reception, of fair loud speaker volume, has been that of station JOAK of Japan. This was accomplished by one of the editors of SCIENCE AND INVENTION, who has confirmation of this reception. Other builders and friends report consistent reception of stations located on the west coast, Mexico, Havana, etc.

Thus the evolution of the receiver-tuner presented here has been after a long period of careful experimental work. The author believes this receiver, of most modern custom-built type, to be far superior to the many commercial receivers of similar type. Because of this belief the author has named the receiver the "Magister" (Latin for Master).

Inspection of the circuit diagram (Fig. 0) will show that six of the *224* and one of the *227* type tubes are used.

The first two screen-grid tubes, V1 and V2, beginning at the left of the diagram, are tuned r. f. amplifiers. Their wave-length band extends over *200* to *550* meters. These circuits are not of the band pass type, although they are inductively coupled. Due to the characteristic of the screen-grid tube, the 1:2 primary-secondary winding ratio and type of inductances used, a degree of broad tuning is prevalent. This broad tuning is desirable, purposely brought about to enable ease of tuning over the band without the necessity for the use of compensating condensers to obtain exact resonance at all wave-lengths.

The third screen-grid tube, V3, is used as a new type of modulator. However, a similar circuit has been employed in Europe for some number of years, differing only by characteristics of the tubes. The screen-grid of this tube is modulated by the oscillator and obtains as well its "B" plus potential from the plate of that tube. The manner in which the modulator tube mixes the frequencies is similar and almost identical with the three element modulator of the late R. E. Lacault's Ultradyne circuit. As the screen grid of the tube requires a definite "B" plus potential, its return is made to the plate of the oscillator tube instead of the grid, as in the case of the Ultradyne. The voltage of both the screen-grid and plate are somewhat critical depending upon the r. f. gain of the preceding stages. Using this tube as a modulator gives the advantages of amplification by virtue of plate supply as used with the old first-detector type of mixer and at the same time has the same degree efficiency and sensitivity of modulation as found in the Ultradyne circuit. Before passing on those who may desire to use this type of modulator in the "Home Builder's Seven" may do so with ease, and to great advantage. The normal screen-grid and plate potentials of the tube should be used in this case.

The modulator tube feeds into two screen-grid intermediate-frequency band pass stages of the inductively coupled type. The degree of coupling has been made adjustable for the degree of band pass desired. The intermediate-frequency stages are designed for *250* kilocycles with a from *5,000* to *15,000* cycle band pass. The *1200* meter or *250* kilocycle frequency was selected in order to approach as nearly a possible one spot tuning and to enable ease of construction of the tuned band pass filter inductances at the lowest possible cost.

Power Detector

The sixth screen-grid tube, V7, is of the power detector type using "plate bend" rectification. No provision has been made on the chassis for coupling to the a. f. amplifier other than the detector

Fig. 1. In laying out the parts for the Magister it is well to follow the picture layout below and the photographs accompanying

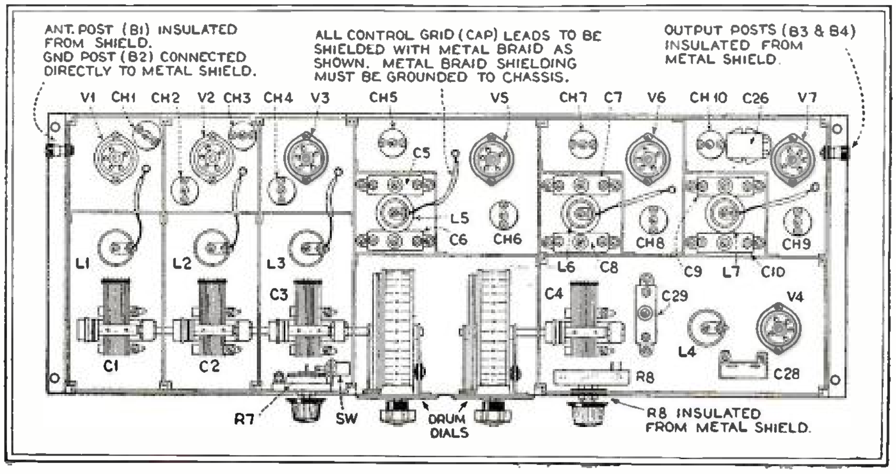


plate lead. The series plate resistor could of course be incorporated on the chassis but as the complete audio and power system are contained in another chassis, it was not considered advisable because of possible circuit reaction, as doing so would necessarily make the grid lead of the succeeding a. f. stage of considerable length. This would be subject to a great many disturbances as can be seen. With many stations, all locals, it will be possible to eliminate the first a. f. stage, coupling directly to the power stage. Sufficient gain to load the 245 power tube may be had in this manner to supply volume suitable for most home use. The detector plate-feed resistance should have a minimum value of 250.000 ohms. The a. f. return is made to the cathode of the detector through a bypass condenser connected to B4, while the "B" supply is obtained from the power supply in the conventional manner. The detector r. f. by-pass condenser, C 26, is also returned to the same point. A capacity of .001 mfd. is used here for filtering of the high audio frequencies. Should these frequencies be desired, the capacity may be reduced to .0005 mfd. and in some instances a capacity of .00025 mfd. will prove satisfactory. The above returns are not made to "B" minus as is usually the case, as, even though the detector bias resistor is by-passed by a 1 mfd. condenser, C 25, there still remains the reactance of this condenser in the circuit. This reactance would tend to attenuate some of the very low audio frequencies.

Suitable Audio-Frequency Amplifiers

The a. f. amplifier may be of any type, within certain restrictions. In a following issue of this magazine will be described a suitable amplifier and power supply. This amplifier employs one stage using the 227 type tube, coupled to the detector through the proper grid blocking condenser, in connection with

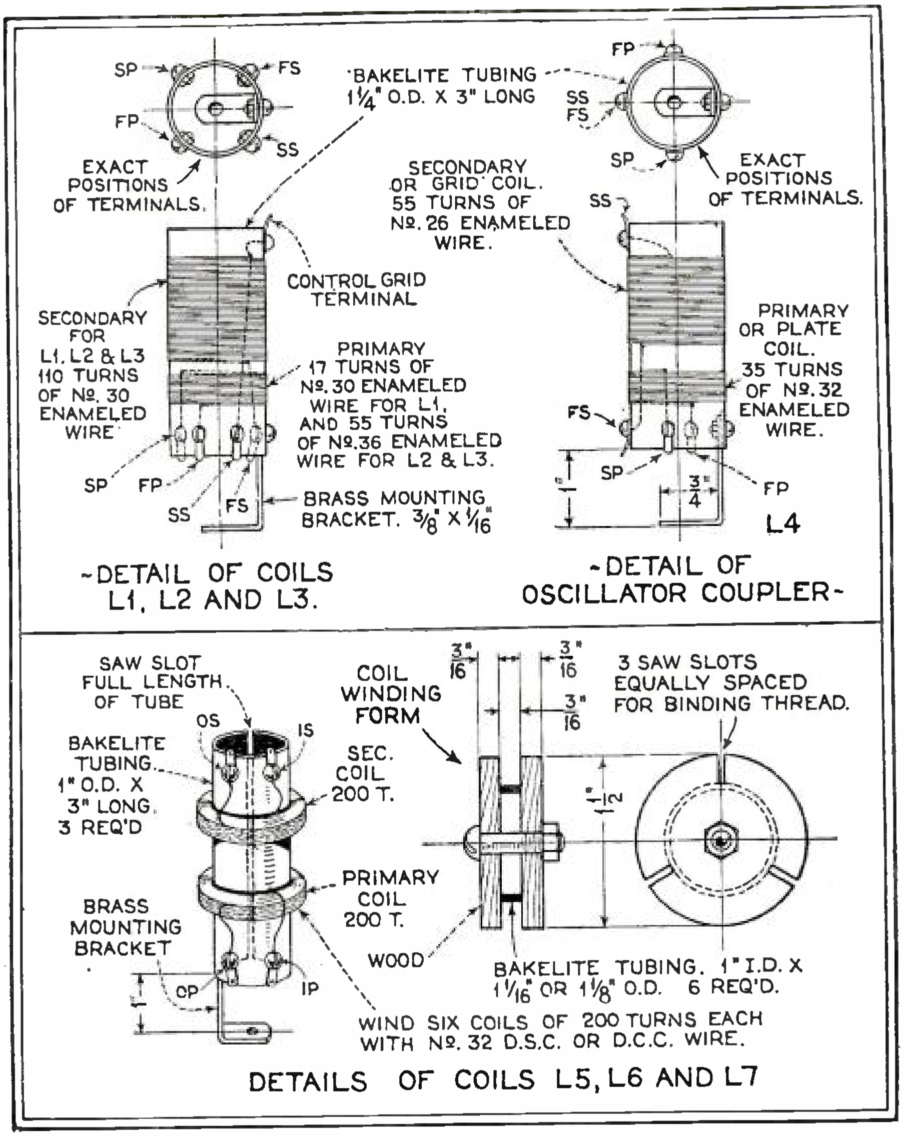
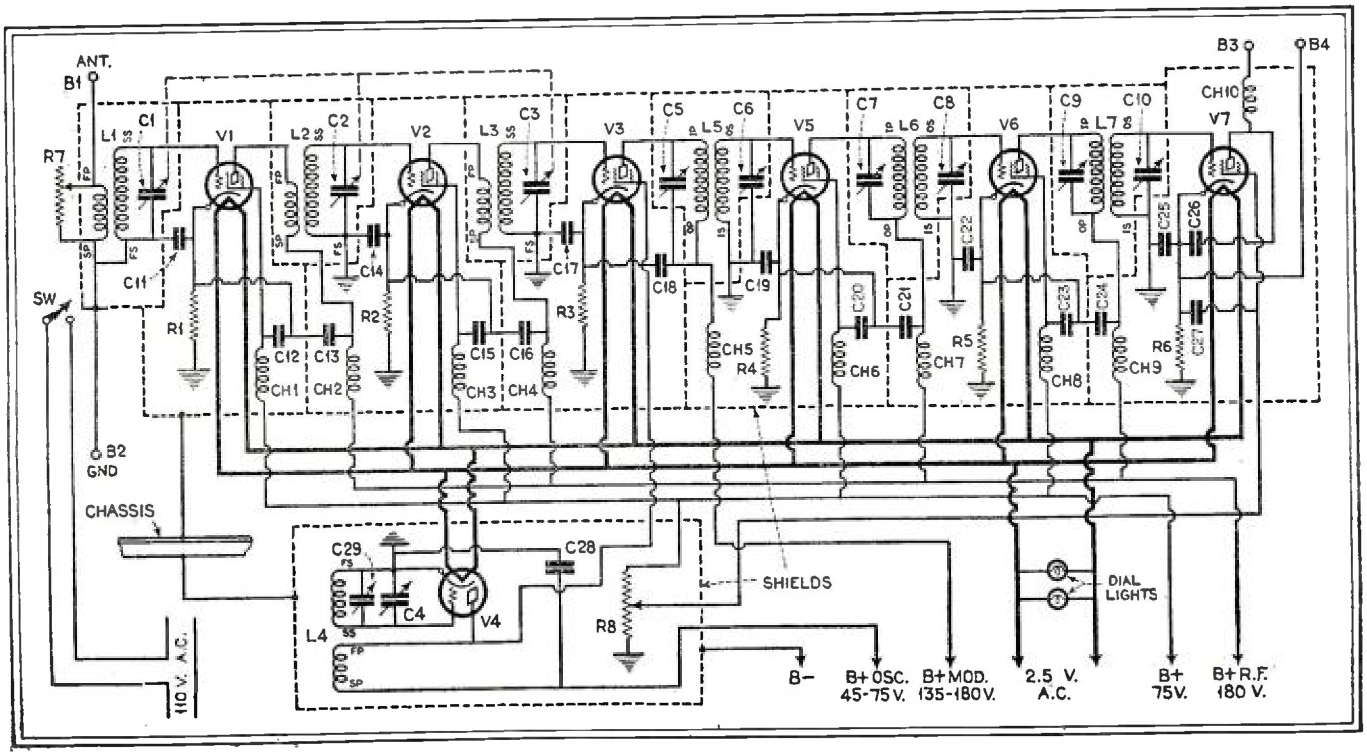


Fig. 2. Full constructional details for all the coils employed in the tuner are given above. Compare the terminal markings with the schematic circuit shown in Fig. 3

Fig. 3. Here is given the complete circuit diagram for the Magister tuner. The parts are numbered to coincide with the parts layout and parts list



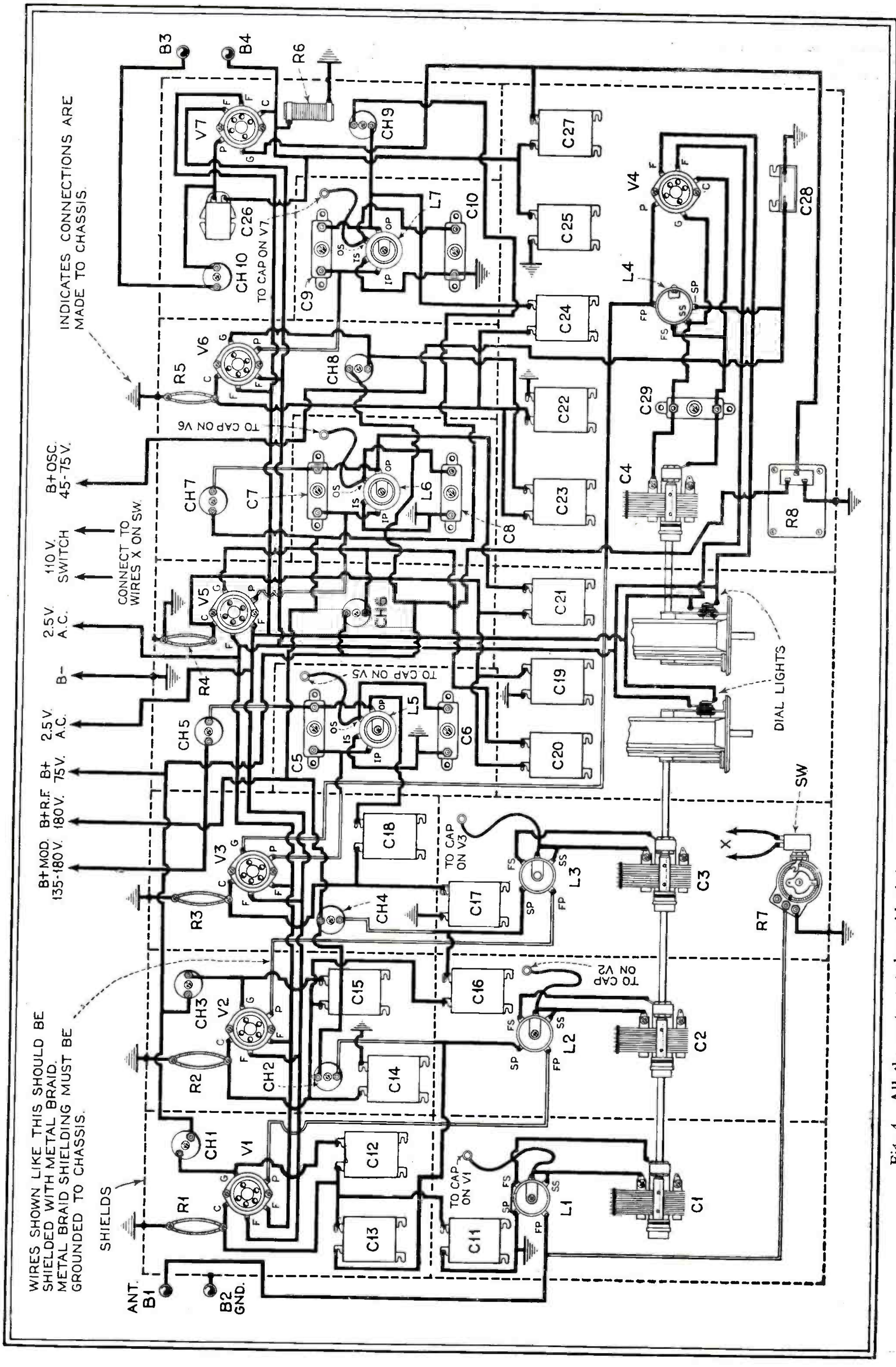
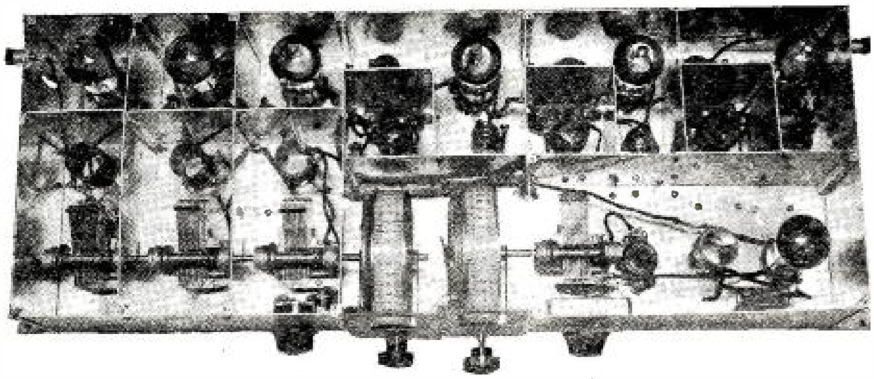


Fig. 4. All the parts, together with their connecting wires, are shown in the relative positions they will take in the completed set



How the Magister looks when completely built

the detector plate-feed resistor. The first a. f. stage is followed by a push-pull stage in which the general purpose power tube, the 245 type, is employed. Such a combination when used with the r. f. amplifier-tuner described here will deliver more than ample power for ordinary purposes and serves to lessen the cost of the complete receiver.

Mechanical Construction

The chassis construction of the "Magister" is of improved design and is simple in construction. It is constructed of such material that lends great strength to the assembly, serving as a base of support and common electrical connection. The aluminum shield compartments have been built as a part of the chassis. The bottom of the shield compartments is a single large piece of aluminum the same thickness as used for the partitions, sides and top.

Selection of Parts

While the constructor will naturally desire to use what parts he may happen to have on hand that will fit into the circuit, it is recommended that rather than chance possible trouble, the parts listed below be purchased new and triple tested as to defects. These parts have been selected with both a view toward the expense, and to their efficiency of operation in the circuit. Size in many cases has also been a factor for selection. However, should different parts be used, care should be taken that additional space be allowed for them when building up the chassis. The chassis has been made as small as possible; as a matter of fact has been built around the parts. The parts required for duplication of the official "Magister" tuner are as follows:

Four Hammarlund .00035 mfd. tuning condensers (C1 to C4).
Two National drum dials, type F.
Ten Pilot 80 millihenry chokes. Inductances smaller than these are worthless in the Intermediate stages (Ch1 to Ch10).
Seven Pilot UY sockets, type 217 (V1-V2-V3-V4-V5-V6-V7).
Seventeen Flectheim 1 mfd. by-pass condensers-250 volt d. c. rating (C11 to C25, C27 and C28).
One .001 mfd. Flectheim midget fixed condenser (C26).
One Antenna Coupler, home-made or commercial (L1).
One Oscillator Coupler (L4).
Two Screen-grid r. f. couplers, home-made or commercial (L2 and L3).
Three Intermediate band-filter transformers (L5, L6 and L7).
Six XL Laboratories Vario-densers, type G5 (C5 to C10).
One XL Laboratories Vario-densers, type G1 (C29).
One Electrad 50,000 ohm Truvolt fixed resistor with tap for detector bias (R6).
Ten Electrad 1400 ohm grid suppressors for Screen grid tube bias. (Important see paragraph on tubes.) (R1-R2-R3-R4-R5.)
One Electrad volume control type AP (R7).
One Electrad Super Tonatrol No. 5. 0 to 100,000 variable resistor (R8).
Four XL Laboratories "bakelite top" binding posts (B1 to B4).
Six Carter Control grid connector caps.
Six Hammarlund slotted corner posts (obtainable directly from manufacturer).
Six Hammarlund slotted partition posts (obtainable directly from manufacturer).
One sheet aluminum 29 x 10 x 3-64 inches.
One sheet aluminum 27¾ x 10 x 3-64 inches.
Six sheets aluminum 9½ x 5¼ x 3-64 inches.
One sheet aluminum 27¼ x 5¼ x 3-64 inches.
Three sheets aluminum 10⅛ x 5¼ x 3-64 inches.
One sheet aluminum 7⅜ x 5¼ x 3-64 inches.
Three sheets aluminum 6¾ x 5¼ x 3-64 inches.
Three sheets aluminum 4 x 5¼ x 3-64 inches.
One sheet aluminum 5½ x 5¼ x 3-64 inches.
Seven aluminum caps (salt and pepper shakers 2¼" diameter by 3" high, the bottoms of which are used as tube port hole covers).
Six Speed type 224 tubes, new type (see paragraphs on tubes). (V1-V2-V3-V5-V6-V7.)
One Speed type 227 tube (V4).
Four pieces bakelite tubing 1¼ inches in diameter by 3 inches long (for L1, L2, L3 and L4).

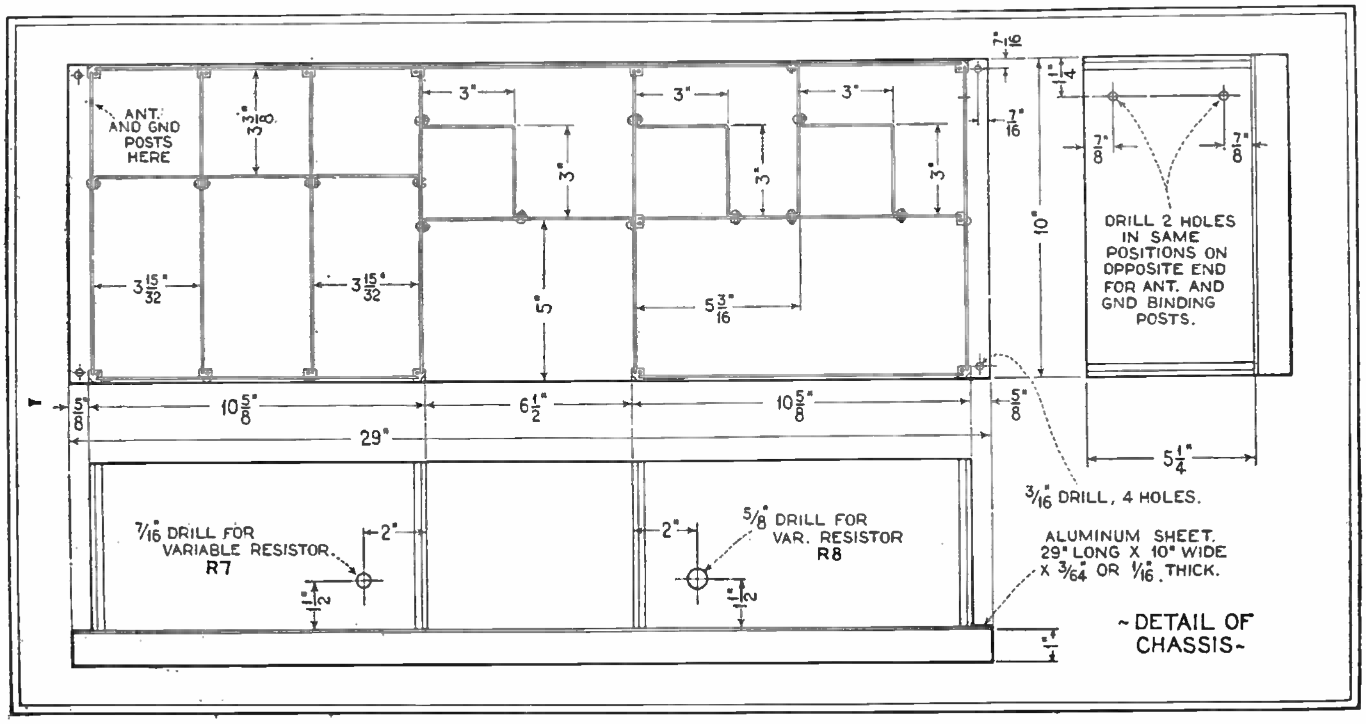


Fig. 5. Not only the coils, but also the tubes are located in shielded compartments, laid out as shown here

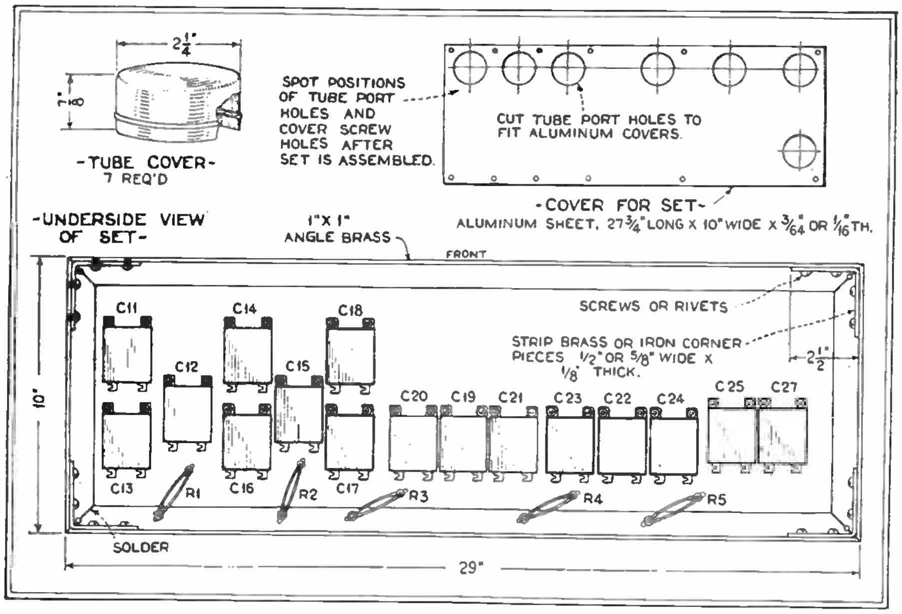


Fig. 6. Details for mounting the various by-pass condensers, location of the tube caps, etc., are given above

Three pieces bakelite tubing one inch in diameter by 3 inches long (for L5, L6, and L7).
Six bakelite rings one inch in diameter by 3-16 wide (core pieces for coils of L5, L6 and L7).
Two pieces angle brass 29¾ inches long by 1 inch by ⅛ inch thick.
Two pieces angle brass 10 inches long by 1 inch by ⅛ inch thick.
Four iron corner angles ½ inch wide ⅛ inch thick and 2½ inches long.

Construction of Coils

The antenna and r. f. coils used in the "Magister" must be of the small field, small diameter type in order that coupling between the r. f. stages is minimized. Otherwise the shielding would prove to be inadequate. Various commercial coils may be obtained on the market that will prove satisfactory when properly modified. The coils are easy of construction and although the commercial product may be obtained for a reasonable cost, the constructor can as easily make them himself.

The secondary windings of L1, L2 and L3 consist of 110 turns of number 30 gauge enamel insulated wire wound on 1¼ inch diameter tubing. The winding will require a space of approximately 1¼ inches. The antenna primary of L1 is wound with 17 turns of the same size wire. The primaries of L2 and L3 are wound with 55 turns of number 36 enamel covered wire. The winding space required will be approximately ⅜ inch.

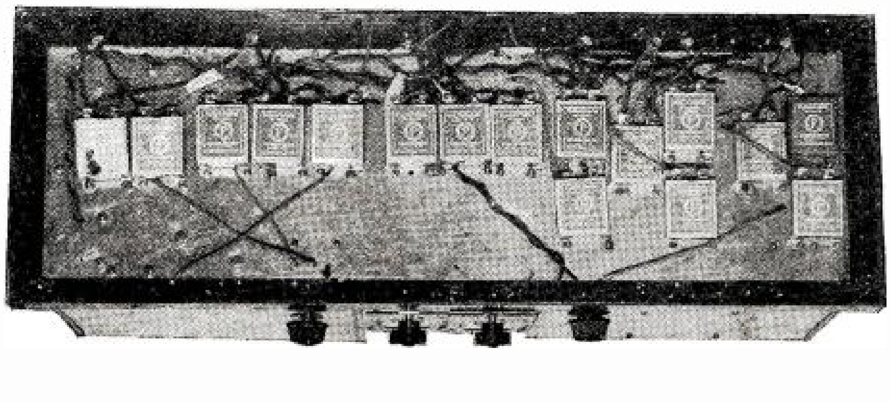
The primary and secondary windings are separated by a space of ⅛ inch. Both windings should be in the same direction. The start or beginning of the secondary winding, designated (S) connects to the control grids. The finish, designated (F) connects to "B" minus. The start of the primary, nearest (F) of the secondary, connects to "B" minus in the case of the antenna primary and to "B" plus 180 volts for the r. f. coils. The finish (F) of the primary of the antenna coupler connects to the antenna binding post (B1) and also to the antenna volume control (R7). The finish of the RF primaries connects to the plate of the tubes.

Special Oscillator Coupler

Inasmuch as the wave length range of the oscillator coupler is considerably different from the other coils, this coupler must be constructed by the builder. It is wound on the same diameter tubing as used for the antenna and r. f. coils. The grid or secondary winding consists of 55 turns of number 26 enamel covered wire. The primary or plate coil consists of 35 turns of number 32 enamel covered wire. The two windings are separated by ⅜ inch. The use of smaller wire for the primaries of the above coils has proved more satisfactory, especially in the case of the oscillator coupler. Its use tends to minimize the production of parasite harmonics by the oscillator as well as overcomes unstable generation as is the case when larger size wire is used.

After the above coils have been wound they are provided with lug terminals for soldered connections. Unless the windings have been made very tight it will be necessary to dope them with very thin celluloid cement. This cement should be used very sparingly in order to cut down distributed capacity. Detail construction of coils is given in Fig. 2.

Below the base are located the numerous by-pass condensers and a good part of the actual wiring of the tuner



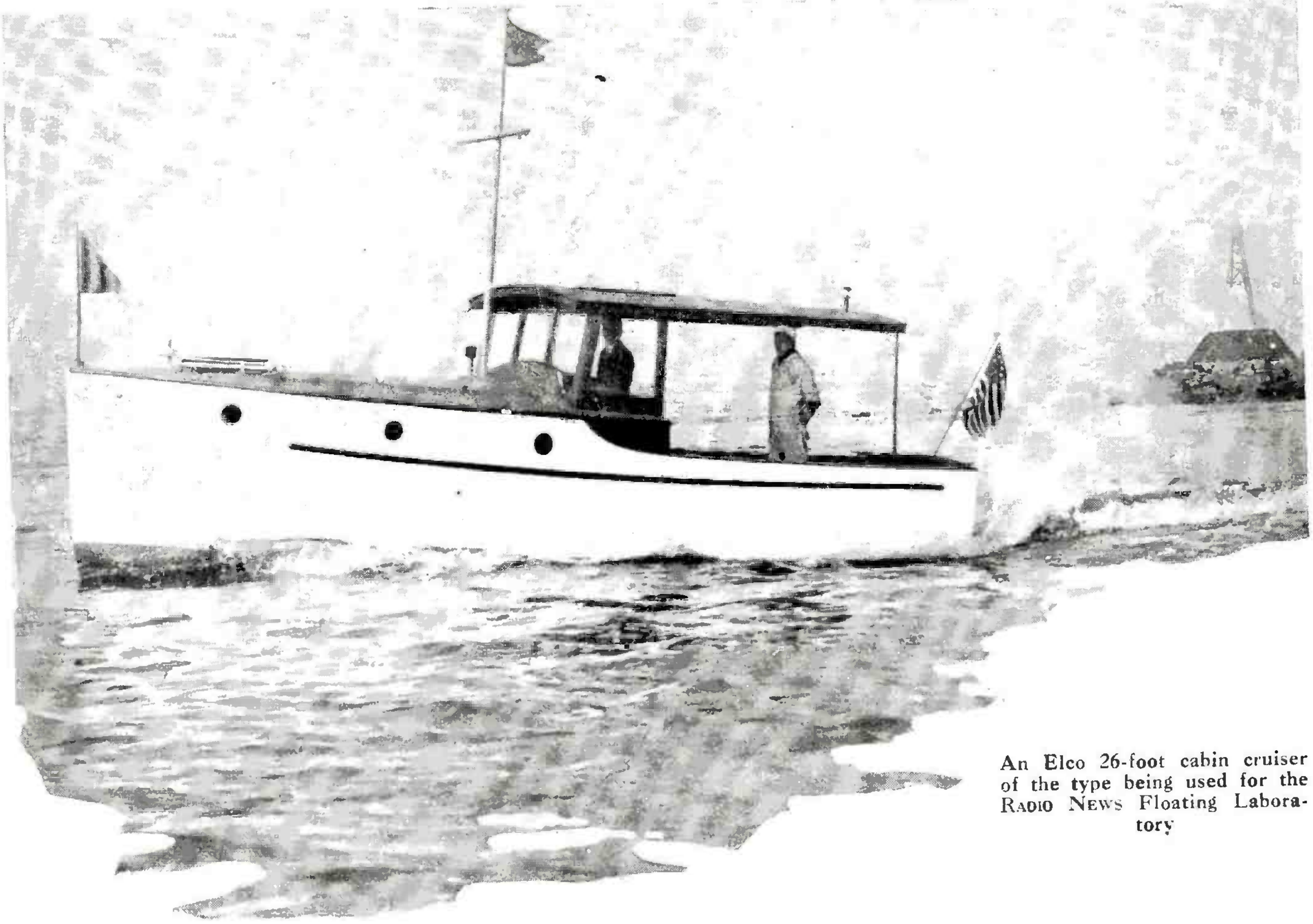
Making the Intermediate Band Filter Transformers

The construction of the coils used for the band filter transformers is very simple While lateral wound coils are desirable. bunched slot wound coils will prove just as satisfactory providing they are carefully made and matched. The latter process may be accomplished by using one of the coils as the grid coil of a modulated Hartley oscillator, and should be shunted by a .00035 mfd. condenser. Placing the other coils in turn, in series with a crystal detector and a pair of phones, the coil to be matched shunted by a .00035 mfd. condenser, the number of turns are adjusted until the signal is loudest. Use of a variable condenser with some sort of scale will expedite this work.

For the coil construction, six bakelite rings one inch in diameter and 3-16 inch in width are required. These rings are clamped, in turn, between side pieces which should have a diameter of not less than 1½ inches. The wire is wound in the resultant slot. The detailed construction of the above described form is given in Fig. 2. The side pieces, as shown in the detail sketch, should be provided with three slots equally spaced around the circumference. The depth of these slots should not be less than ¼ inch. Each disc is provided with a hole drilled through the center. The discs with the bakelite rings are assembled and clamped together by passing a machine screw of sufficient length through the assembly and tightening with a nut. The discs can be made of any stiff material, preferably bakelite ⅛ or 3-16 inch thick. When the form has been assembled, the slots of the side pieces should be aligned and a length of strong linen thread placed in each slot across the surface of the bakelite rings. The tie strings are used to hold the winding in place and shape after the side pieces have been removed and until the coil is doped.

Six coils are wound, each with 200 turns of number 32 DSC or DCC wire. When wound each string or thread is tied around the winding, at which time the side pieces may be removed. No excessive care of winding the wire in the slot is necessary. The more the scramble, the better, as this will result in a coil of lower distributed capacity. When all the slot wound coils have been made and the side pieces have been removed, the constructor will have six coils with a bakelite core. These coils are now soaked in thin celluloid cement, allowed to stand until the cement begins to set, at which

(*Continued on page 372*)



An Elco 26-foot cabin cruiser of the type being used for the RADIO NEWS Floating Laboratory

By W. Thomson Lees
Managing Editor

Radio News FLOATING LABORATORY

Promoting Entertainment, Navigation Aids and Communication by Radio for the Pleasure-Boat Owner

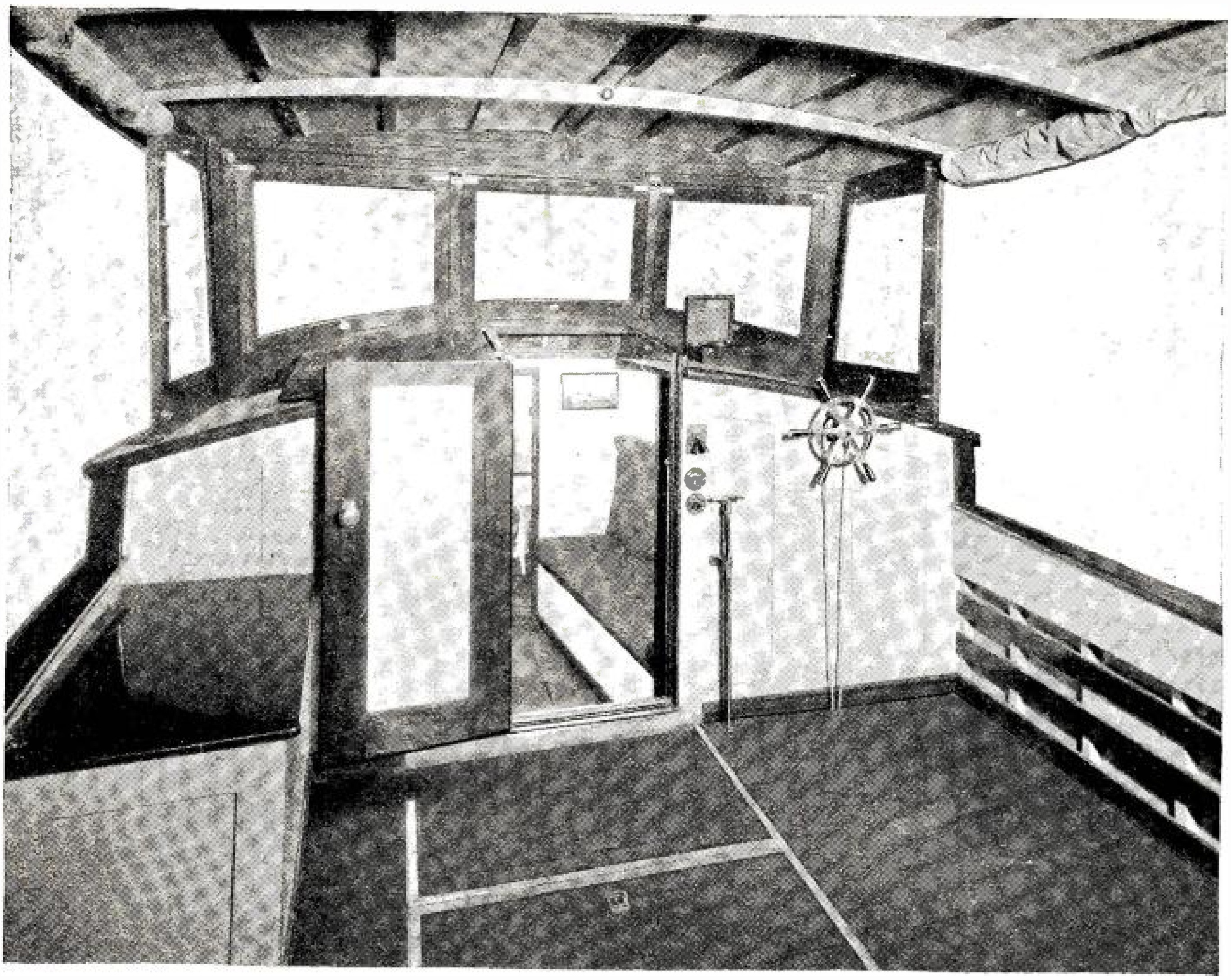
BY the time these pages are in print the experimental work of the technical staff will be well under way, looking toward the development of—first, a receiver, and later on a transmitter—which will afford to the small boat owner all that he has a right to look for from radio. This means not merely entertainment, but weather reports, time signals, direction finding; in short, *real* radio service.

In our November issue we will present a complete account of this work up to the time of going to press.

IN the case of worthwhile radio ideas, no less than in golf, the important thing is the "follow through." Last month, we had Mr. Lloyd Jaquet present (RADIO NEWS, September, 1929, page 212) the question "Why Not Get the Utmost from Radio on Your Pleasure Boat?" Well—why not?—was the question that kept humming in the heads of the editorial staff. Since everybody we asked seemed to think the answer worth finding, we decided to go after it.

In the first place, there are thousands of pleasure boats plying the waters of these United States, serving as vacation-outing headquarters for their owners. These boats range from small launches to medium-sized and big yachts; but probably the greatest number of them lie within the sizes from about 25 ft. to 50 ft. of the small cruiser type, if we eliminate the ones that are used only for *getting* somewhere, rather than for *being* somewhere.

It is perfectly true that some of the larger sizes of these boats are (in a manner of speaking) "equipped with radio." Not one of them, as a matter of fact, is really equipped with a radio installation that enables its owner to get even a fraction of what radio can give him in the way of (1) safety, (2) aid to navigation, (3) time and weather information and (4) entertainment. Why not?—because,



Looking forward from the stern of the cockpit. The engine being located under the hatch (in the middle foreground) puts the source of ignition interference practically amidships. It is obviously impossible to locate a receiver far enough away so that distance alone will eliminate this interference

as yet, there simply "ain't no such animal."

Note that we said, above, that some of the larger cruisers are furnished with radio equipment. This means, simply, a radio set for entertainment; except in the case of boats more properly classed as yachts, in which case a licensed commercial operator is carried.

What we are interested in, is the owner-operated cruiser, used for week-end trips or even more lengthy cruises. We want to develop a receiver that will be almost as important to the owner of this type of boat as his rudder. It has to be ready to while away the time, when all's well, with really high quality entertainment from broadcasting stations; it has to be capable of serving as a direction-finder; it must reach up to the wave-bands on which marine beacon stations operate; it must reach down to the short wave-bands. (The last-named requirement will be enlarged upon, later on.)

With all this, there are other requirements to be met. First of all, ignition interference must be faced and conquered. Next, the set must be so designed as to defy the ravages of salt water. Last, but decidedly not least, both the receiver and its power supply must keep within rather rigid requirements as to size and weight.

In case this brief summary of the conditions to be met is not enough, a more elaborate outline was contained in our previous issue. However, it is one thing to discuss these requirements in the abstract, and quite another thing to attack them concretely. We have, of course, the RADIO NEWS Laboratory; and we intend to make use of it. But we might develop a theoretically beautiful receiver for small cruisers, in the Lab, only to have it turn out that actual practice on a boat is something else again. Obviously, the proof of the pudding lies in the eating.

As this is written, the writer has just returned from a brief trial trip on the newest extension to our laboratory facilities: a 26 ft. Elco cabin cruiser, put at our disposal for this purpose by the Elco Boat Works, of Bayonne, N. J. As described by the manufacturers, this boat is "the smallest practical cruiser"—which makes her ideal for our purpose; because she offers every handicap of size and space, and the results of our experiments will therefore be applicable to cruisers of all sizes.

The trial trip referred to was merely a short run, out in Newark Bay. By the time these lines are in print, however, we expect to be so familiar with our floating laboratory as to call every plank by its first name. More important, by dint of night work and week-end efforts, we expect to have some interesting practical data to unfold before another month rolls around.

We might mention, parenthetically, that if you don't own a boat, or if you don't know a man who owns one, you're missing something. If you live up North, here, you're missing something from April to October; if you're down below the freezing line (or, rather, down *above* it) you're missing something, the year around. No dust; no crowded roads, no need to follow a concrete ribbon—but we'd better pipe down (note the influence of that trial spin) and stick to our subject.

First, then, we're going to go after the bugaboo of interference from the engine. If you have to shut off your motor every time you want to listen to a good radio program, you can't cruise very far. More important, if you get caught in a fog, you don't want to lose steerage-way every time you try to catch a direction-finding signal.

Once we have interference lashed to the mast (getting nautical, again) the other problems will be taken up piecemeal. Circuit possibilities are, of course, many; arrangement of parts, selection of parts, selection of tubes; all of these, and many more, are variables. In a way, it is like trying to solve an intricate algebraic equation having a dozen or so unknowns and only two or three known factors. Which is exactly why the only practical approach lies in a method of "cut and try."

The known factors are: that where the small size of the boat precludes locating a receiver far from the engine, interference from the ignition system is inevitable; that a highly efficient antenna system is out of the question; that weight and size of the receiver must be kept down, because of space limitations on board; that A and B power supply must be suited to the conditions involved.

Oh, yes; there is one additional known factor which we forgot to mention: the name of the boat. If we find time, we'll hold appropriate christening ceremonies; if not, she will have to be content. At any rate, she will bear the dignified title RADIO NEWS FLOATING LABORATORY.

The illustrations on these pages give a fair idea of what our floating Lab. looks like. While not pictures of the boat itself, they are views of one of her sister ships, as like as two peas in a pod. The cabin has sleeping accommodations for four (not that we expect to find much time for sleep during the coming month!) and the cockpit is almost as large as the average nightclub dance floor.

Powered with a 27 h.p. engine, this cruiser makes about ten miles per hour—no challenge to the Bremen, but plenty fast enough to keep going. As will be seen in the illustration taken from the rear of the cockpit, looking forward into the cabin, there is a flush deck hatch immediately aft of the cabin doorway. Under this hatch is the engine, with its electric starter, as well as the storage battery which operates both the starting and lighting systems.

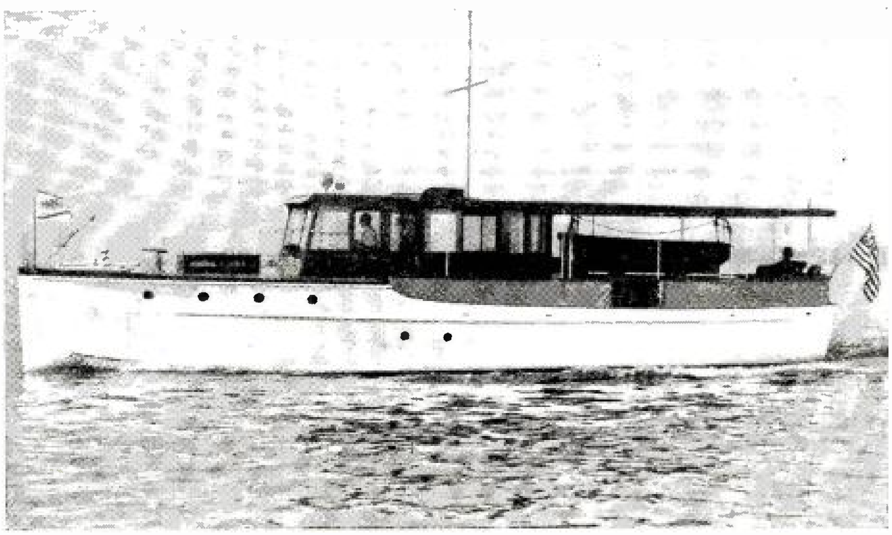
Under that hatch, therefore, is the source of our first major problem: ignition interference. On a fifty-footer it is possible to get a radio set far enough away from the engine to minimize such artificial static; on a twenty-six footer, with the engine almost amidships, that won't work. Whether it will be a case of only special spark plugs and partial shielding, or whether more elaborate methods will be required, will not take very long to determine.

There isn't the least doubt that the Floating Laboratory's cockpit is plenty large enough to permit putting there a most elaborate console type radio set with built-in dynamic speaker. Nor is there any doubt of what would happen to console and set, after the spray from a few whitecaps had played around with them. Nor is there any 110 volt a. c. floating around the water these days. No—the a. c. receiver is definitely out.

The *Mouette*, famous honeymoon cruiser of Col. Lindbergh and his bride. It is boats of this type, ranging from 25 to 50-foot in length, that have found the widest popularity, and it is for this class of boat that all-around radio service is as yet unavailable

We are, however, going to take a variety of battery-operated receivers aboard, for comparative tests. And these, incidentally, will give us a line on the efficiency of signal pick-up, as compared with the ordinary home location.

It is obviously impractical to do any amount of actual constructional work on board. That, of course, will have to be done at our base laboratory. If it were not for that—and the comparatively insignificant details of editorial desk work—we might be tempted to forsake the crowded city and embark on an extended cruise. But, being fully alive to the importance of radio—*real* radio—in such a venture, we'd much rather wait until we have developed the receiver for the job.



A 50-foot cabin cruiser. Many boats of this size are equipped with radio, but usually only for entertainment purposes

Too many people measure radio solely by the standard of broadcast entertainment. They know only vaguely, if at all, that there are such things as radio beacons, weather reports, storm warnings, time signals. If it were merely a case of designing a "salt-air proof" receiver in more-than-usually compact form, so that a boat owner could bring in a jazz program or a concert to while away the time, the whole proposition on which we have embarked would be hard to justify.

At the same time, until boat owners learn how radio can serve them, there would be scant interest in a specially-designed receiver which ignored the broadcast entertainment feature. And, with the other more difficult requirements we have mapped out, it is comparatively simple to include good broadcast reception.

But, as we said earlier in this article, the proof of the pudding lies in the eating. We want you to know what we are doing and planning, but your real interest lies in the concrete results of our work, and not at all in long-winded discussions of how we are going about getting these results.

When this issue of RADIO NEWS reaches you, we will already be seriously and intensively at work—three men in a boat.

In the next issue, we confidently expect to have some worthwhile reports to make. Until then—RADIO NEWS FLOATING LABORATORY, signing off.

How to Build a 245 AMPLIFIER for the RADIO NEWS Foundation

RADIO NEWS readers who have constructed the R-N Foundation Tuner described in last month's issue of this magazine are undoubtedly ready to add to it some acceptable type of amplifier; that is, if they have not already done so. This article concerns itself primarily with the description of a suitable amplifier and power supply device, and secondarily with the instructions governing the installation of a tuner and amplifier power supply device in a console cabinet, which also houses an electrically-operated phonograph with magnetic pick-up.

General Considerations

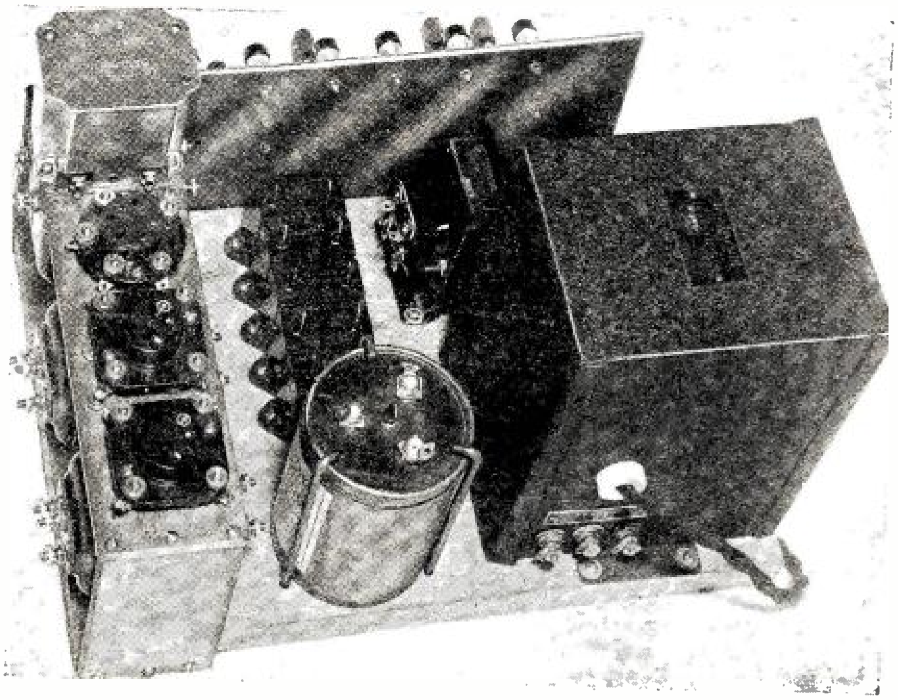
In designing this unit intended purposely for use with the RADIO NEWS Foundation Tuner Unit, several considerations had to be kept in mind. First, a suitable audio channel had to be provided, so that the high level of signal developed by the tuner unit could be handled satisfactorily without overloading. To satisfy this first demand, a pair of 245 tubes have been used in the final or power audio amplifier stage. It is preceded by a stage of audio amplification employing the 227 tube. Reference to the circuit diagram Fig. 1, will show the connections for the entire audio channel. Secondly, the device had to supply not only an audio channel for the tuner unit but also the "B" supply for the plates of the various audio amplifier tubes and also for the plates of the tubes employed in the tuner unit. Thirdly, it had to supply the a. c. filament voltage to the tubes in the audio amplifier and tuner units.

In the Thordarson power transformer employed in this power supply device, the filament voltage for the audio amplifier tubes is readily obtained by a filament supply winding provided for the purpose, but for the tuner unit a separate filament transformer, supplying the correct filament voltage, must be obtained. The filament transformer selected for this purpose is designed to supply current to four a. c. tubes of the 227 or 224 variety, three in the tuner and one in the audio channel. If the amplifier-power supply device described here is used with any other tuner unit employing more than three a. c. tubes, then another type of transformer which supplies the correct filament voltage at the correct amperage, depending on the number of a. c. tubes employed, will have to be used.

Considering that the entire installation is to be housed in a console cabinet containing an electrically driven phonograph motor with magnetic pick-up, the fourth requirement that this unit had to meet, was the ability to change readily from the radio tuner unit to the phonograph pick-up, when desired. As will be seen from the circuit diagram, Fig. 1, a number of switches have been employed to make this possible. In Fig. 2, the position and location in the circuit of these switches, is shown. The double-pole double-throw jack switch, SJ, is used to connect the power amplifier to either the RADIO NEWS Foundation Tuner Unit or any other suitable tuner device, when in one position and to the phonograph pick-up when in the other position. Control of the filament supply of the tuner unit is independent of this switch and must be operated separately when the radio receiver is to be turned on or off. Similarly when the phonograph is to be turned on, then the line switch in the phonograph motor cord which plugs into the 110 volt a. c. supply, must be turned on to start the turntable motor. It will be also noted that there is a pendant switch to control the 110 volt a. c. supply to the audio amplifier-power supply line transformer.

The Audio Amplifier

In all, four transformer units are employed in the audio channel. T1 is the input transformer which couples the plate of the detector tube of the tuner unit to the first amplifier tube. This first stage, which employs a 227 tube, inputs directly into an intermediate stage push-pull transformer. This, in turn, connects to the grids of the two 245 power amplifier tubes and then from the plates of these tubes to the primary of the output transformer. The secondary of the output transformer connects directly into the voice coil of any suitable type of dynamic speaker or to the existing types of approved magnetic speakers. The fourth transformer employed, T4, is a phonograph-coupling transformer and is used to couple the phonograph pick-up to the primary of the first stage audio transformer, T1. By its use, the impedance relations between the magnetic pick-up and the input of the transformer T1 are satisfied.



An over-all view of the 245 power-amplifier power supply device. To the extreme left is the audio channel mounted on and under the shelf. In the center is the filter condenser and by-pass condensers. To the right is the Thordarson power compact, while to the rear is the voltage divider panel with output binding posts

The correct filament voltage for the pair of 245 tubes is obtained directly from a winding on the Thordarson power compact unit. The filament supply for the 227 tube employed in the first stage of audio-frequency amplification is obtained directly from the separate filament transformer T6, which also supplies the filament voltage to the tubes employed in the tuner unit.

Grid biasing of both the first and second stages of audio amplifica-

POWER SUPPLY DEVICE

Tuner

By John B. Brennan, Jr.
Technical Editor

tion is obtained by means of resistors, placed in the circuits so that a sufficient voltage drop, equal to the required grid bias voltage, is obtained. In Fig. 1 resistor R6 supplies the necessary voltage drop to furnish the grid bias for the first audio amplifier tube, while the resistor R7 provides the voltage drop necessary to supply the grid bias for the two 245 tubes.

The Power Supply Device

In this installation a simple, accepted type of power supply unit is employed. It makes use of a power transformer, delivering at its secondary 300 volts either side of the mid-tap; this secondary voltage is rectified by a full-wave rectifier tube V4. From there on, the filter unit, consisting of two filter chokes and an electrolytic condenser bank of three sections, filters out the d. c. ripple so that a pure d. c. is supplied to the voltage divider. The voltage divider consisting of a number of separate wire wound resistor units is provided with several tapped outlets so that not only are the plate voltages to the tubes in the amplifier channel supplied but also the plate voltages to tubes in the tuner unit provided.

Construction

On a 1 inch board, 9 inches wide by 13½ inches long are mounted the various parts which go to make up the entire power supply and audio channel device. Reference to the parts layout, Fig. 4, will show the placement of these various units. The entire audio unit with phonograph transformer is located at the extreme right end of the baseboard. Phonograph transformer T4 and the three sockets for the three audio tubes are mounted on a shelf which is supported off the baseboard by two end pieces. The details for the construction of these end pieces are shown in Fig. 5. Underslung from the bottom of this shelf are mounted the three transformers; the input transformer to the first audio stage, the intermediate transformer connecting the first audio stage to the push-pull power tubes and the output transformer. Details showing the construction of this shelf will be found in the accompanying photograph and sketches.

In the extreme upper left-hand corner of the baseboard is located the Thordarson power transformer, T5. Directly to its right, between it and the shelf containing the audio channel, is located the three-section Mershon electrolytic condenser unit C2, while to the front of this condenser is mounted the five filter condensers which shunt the various sections of the voltage divider. To the front of the baseboard at the extreme left is located the socket which takes the rectifier tube, V4; to its right is located the filament transformer, T6. Along the front edge of the baseboard is mounted a bakelite panel which holds the various voltage divider resistors and also the binding posts for connecting the B plus power and a.

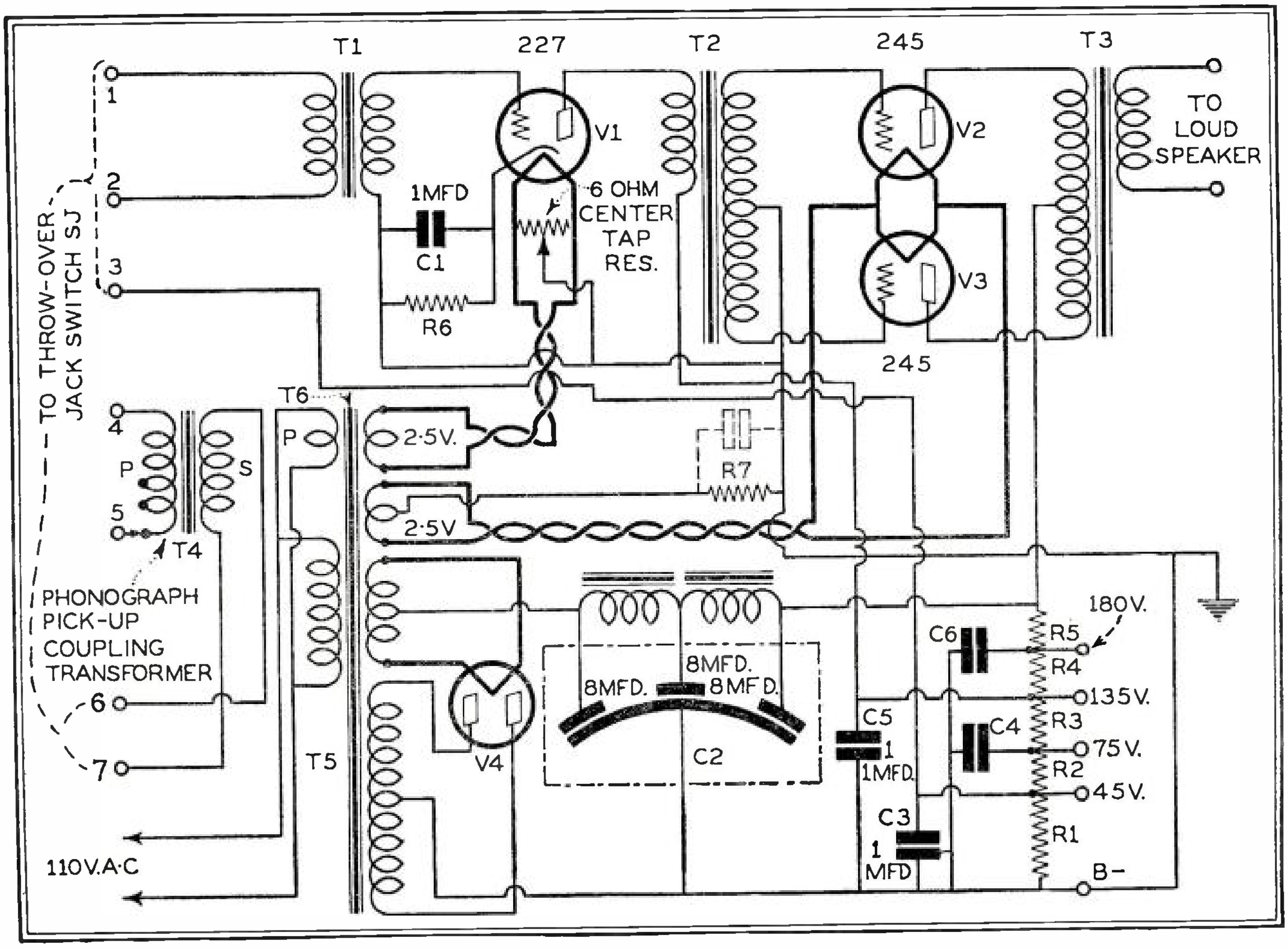


Fig. 1. The 245's schematic circuit. Along the top is shown the audio channel, while below is the power supply circuit details

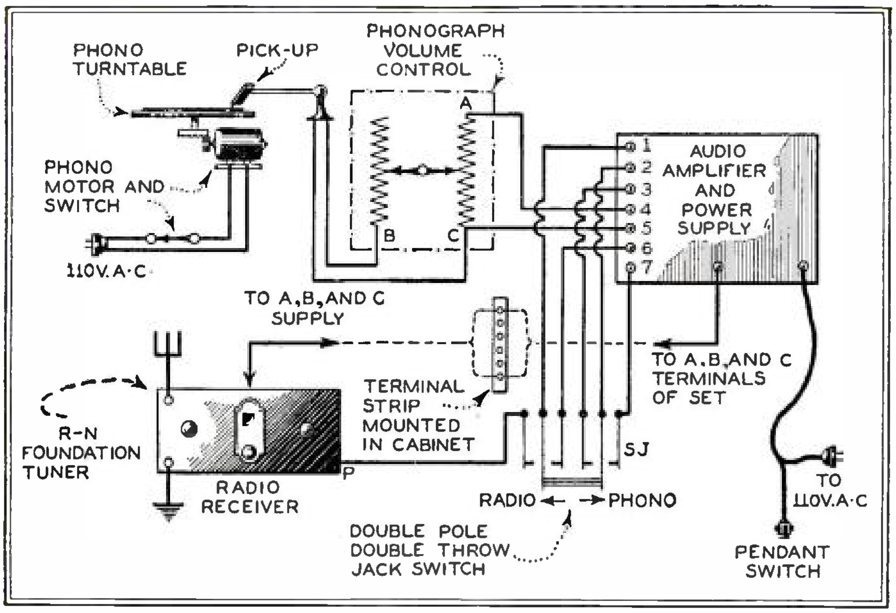
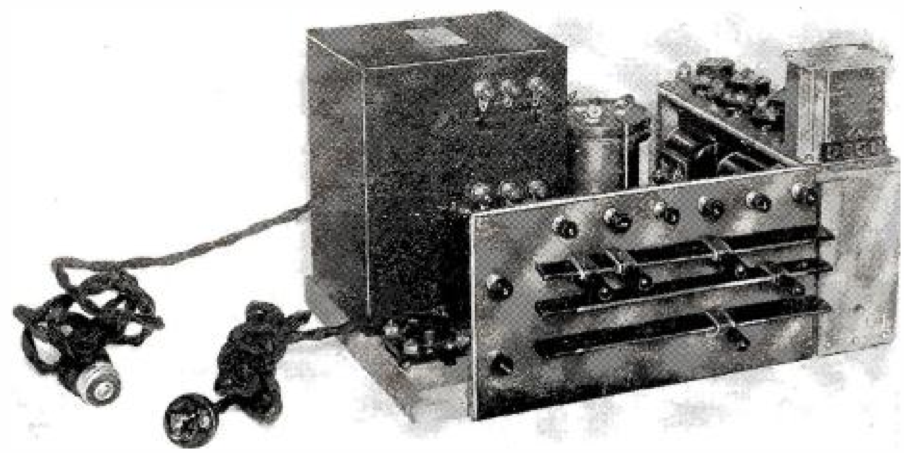


Fig. 2. To connect the amplifier-power supply device to a phonograph pickup and radio tuner the above diagram will prove helpful

The Mershon condenser is not supplied with any means for fastening it to the baseboard, so therefore it will be necessary to provide a suitable way of mounting it in place, permanently. In the laboratory we made use of several pieces of round brass rod bent at right angles at one end and threaded at the other. These pieces serve to clamp the condenser unit down to the baseboard. The threaded ends pass through holes in the baseboard and are fastened with nuts which are located in a counterbored recess drilled into the underside of the baseboard.

The heavier units, such as the power transformer, T5, and the filament transformer, T6, should be firmly fastened to the base by means of one-inch wood screws which should be provided with suitable washers. The use of smaller screws will do undoubtedly as a temporary measure, but if the unit is to be moved around considerably, then it will be found that quite likely the weight of these transformers will cause the screws

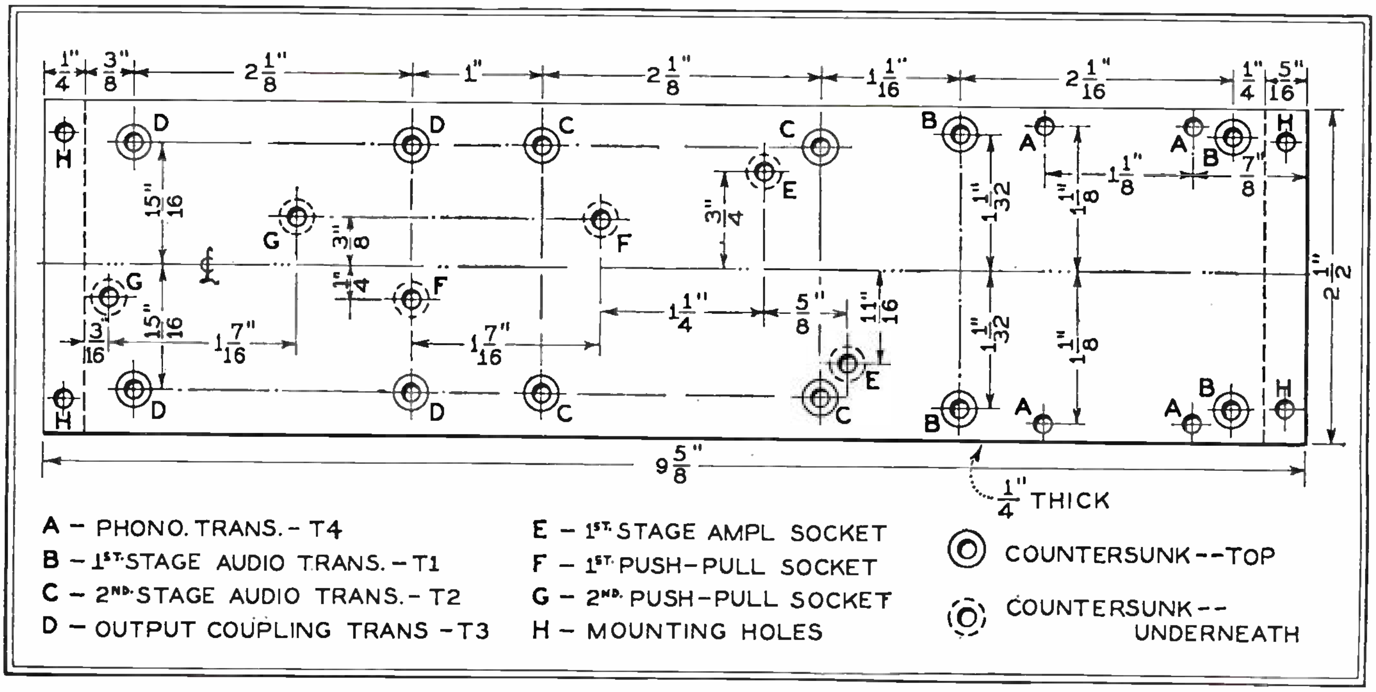


Connection to and adjustment of the plate voltage outputs for the tuner unit is made on the front panel, on which is mounted the voltage divider and output terminals

c. filament leads of the tuner unit to the power supply device.

In laying out the position of the holes for mounting the socket and transformer units on the shelf. it will be necessary to follow quite closely the layout which is given in Fig. 3. It will be noted in this layout of the shelf, that some of the holes are countersunk on top while some are countersunk from the bottom. This is so that the units which mount on top will not be obstructed by the heads of the screws which hold units which are mounted from the underneath side of the shelf. Along with the layout shown in Fig. 3 is given the idenification marks of the various holes, so that no trouble need be experienced in locating the various pieces of apparatus in their correct position. This shelf with its supporting end pieces may be made from some scrap pieces of bakelite or may be fashioned from wood which may be found around the shop. It should be remembered that if the end pieces are of greater thickness than those which are indicated in the drawing, then allowance will have to be made in the overall length of the shelf so as to come flush with the surfaces of the end support pieces.

Fig. 3. In drilling the shelf to take the audio transformers, etc., follow the drilling layout below.



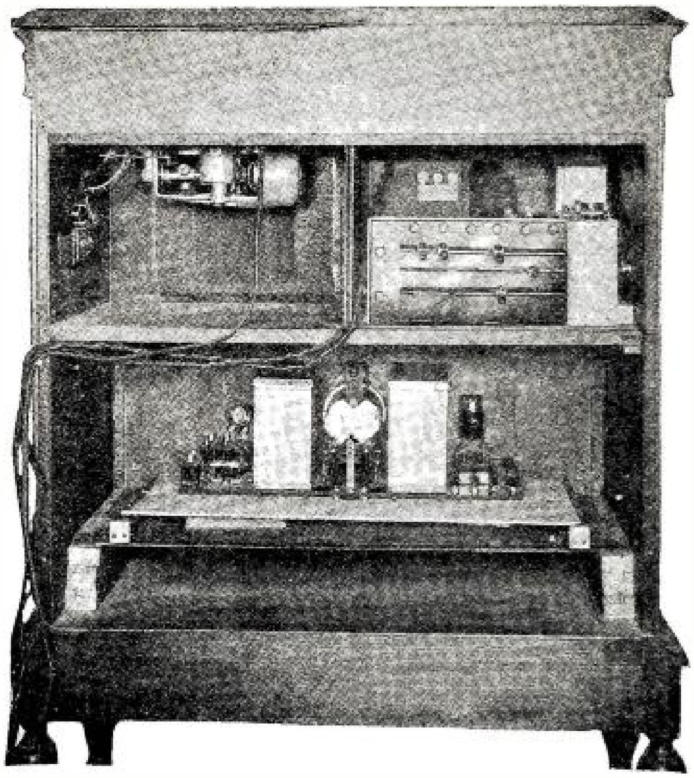
to pull out from their holes and make remounting of them necessary.

In the kit of Carter voltage divider resistors, which is obtained under the catalog designation of No. 2314, three resistors are provided, one of which is a plain resistor without slider tap, the second a two section resistor with two slider taps and a third having three slider taps. In the way in which this kit is used here, it is necessary, before mounting the resistors on the panel, to take one of the sliders off the second unit and place it on the first. Also, it is necessary to join together by means of a wire connection, the two sections of the second resistor strip. Arrangement of these resistors is shown in Fig. 6.

The resistors may be mounted on any scrap piece of panel (which will undoubtedly be found in the junk box) by means of small brass angle pieces readily obtainable in a hardware or 5 and 10 cent store.

Wiring

In wiring this amplifier and power supply device there is one thing that should be kept in mind quite firmly. That is, that all of the wires which terminate at the filament posts of the various tubes should be twisted so as to minimize the possibility of the production of hum in the loud speaker. Moreover, since the current consumed by the tubes is quite high, it will be necessary to use heavier wire than is usually employed in the wiring of d. c. receivers. Wherever possible leads should be bunched together and formed into a suitable cable. In every case, the connections should be soldered so as to preclude the possibility of connections becoming loose once the unit is put into operation.



Here is the 245 amplifier supply device housed in the console, in which is located the phonograph and R. N. Foundation tuner unit

Operation

The amplifier-power supply device described here has been designed primarily to fit the space which is available in the console cabinet used. By the same token the layout of the various switches and the volume control regulator, has been made with a view to accessibility in this particular type of console cabinet and it is likely that where another type of cabinet is employed, some other arrangement will be found necessary. However, the general layout and especially the connections of the various units, one to the other, will remain the same. It is well, for instance, to have the line switch which controls the 110 volt supply to the phonograph motor mounted as near to the turntable as possible. The double-pole double-throw switch, SJ, may be mounted either on the tuner unit panel or in the "well" containing the turntable.

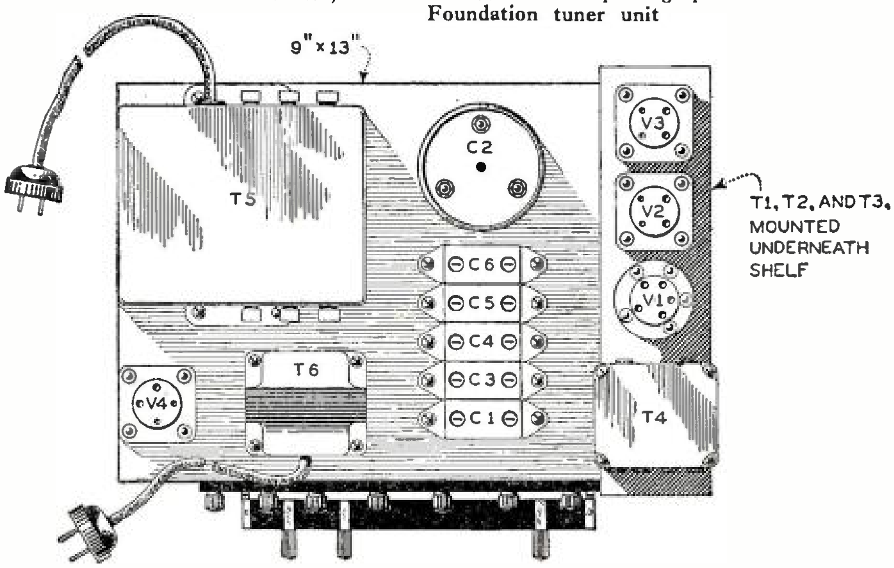
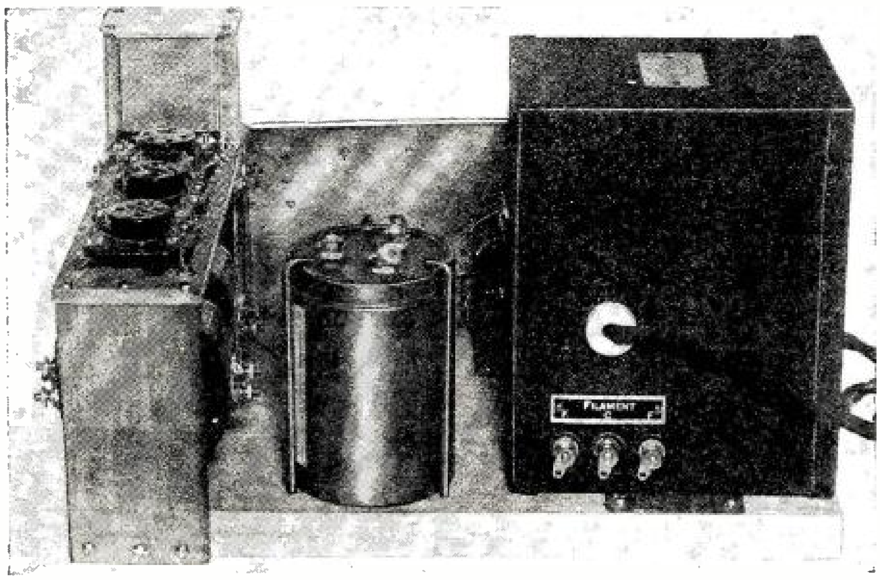


Fig. 4. The layout of all the parts which are to be mounted at the base and shelf in the above sketch. Compare it with the several phonographs accompanying



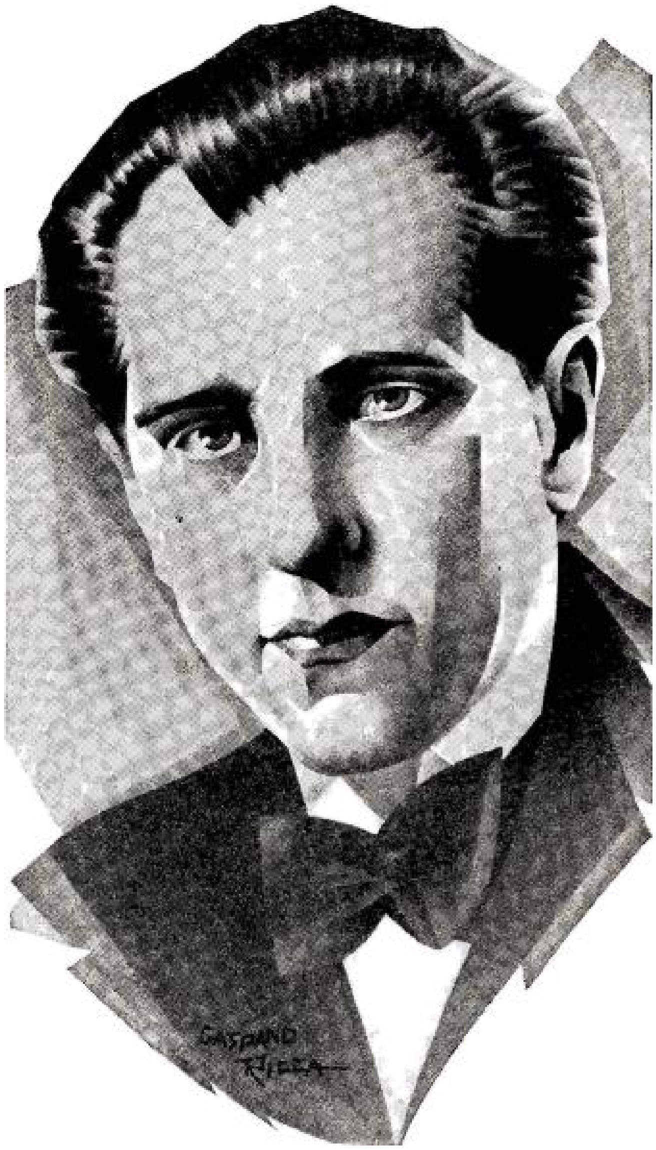
A rear view of the power unit. Note how the filter condenser is fastened to the base

The volume control, of course, should be mounted in the same compartment which houses the turntable so that ready control of the volume from the pick-up can be obtained. Actual control of the line voltage to both the audio amplifier-power supply device and tuner unit is, of course, controlled by the pendant switch which should be connected to a cord sufficient in length to be readily accessible from the front of the console cabinet. If it is desired, another switch which connects in the filament supply to the radio tuner unit may be employed so as to control the filament supply to the tuner independently of any of the other switches. Thus, when the phonograph is in operation, it will be possible to turn

(*Continued on page* 381)

The Personality the Ghost

By Frances Rockefeller King



Courtesy National Broadcasting Company

Joseph Dunninger; drawn from life by Gaspano Ricca

"GOOD evening, ladies and gentlemen. This is the National Broadcasting Company, New York City. We are about to present a man whose reputation is world-wide, and perhaps the best known and most widely accepted authority on psychic phenomena. . . . Joseph Dunninger. . . ."

Undoubtedly, a large proportion of the radio audience received not only this announcement, but the "Ghost Hour" which it introduced, with more than a grain of skepticism. Dunninger, seated at the microphone in the New York studio of the National Broadcasting Company, projected three thoughts over the N. B. C. network. Listeners-in were invited to try to receive this projection, and to send in their replies. The items projected by Dunninger were as follows: the name of a president (which proved to be Lincoln); a number composed of three digits (3-7-9); and a small drawing or diagram (which consisted of a small house, four windows, one door, a triangular roof, and chimney).

Over two thousand letters were sent in to the National Broadcasting Company from all parts of the country. Of these, over fifty-five per cent. had some part of the thoughts correct.

Whether we are prepared to accept Dunninger's theory or not, we must at least admit that this large percentage of nearly correct vibrations received proves mental telepathy a possibility, and when we stop to think that over forty per cent. got the name of Lincoln right, and that over five per cent. received the entire array of thoughts correctly, the outcome of these demonstrations via radio furnishes food for thought.

Dunninger has done many things for which there seems to be no ready explanation. About a year ago, his car was stolen, and when found, was discovered wrapped around an elevated post. When the theft was reported to police headquarters, the captain laughingly requested that the owner demonstrate his ability as a mindreader by locating the car, and the thief. In this remarkable test Dunninger succeeded, and inasmuch as the knave is now serving a term in the penitentiary, having been proved guilty of this offense, it goes to illustrate that this was not a press stunt, as many believed it to be at that time.

His accomplishments and unique ability have astounded millions. yet the most marvelous feature of it all is that he is but thirty-six years of age. Never before in the history of the magical world has a man been able to climb to the top rung of the ladder of successful endeavor at so early a period in life. The late Harry Houdini, one of the greatest characters of universal show-world, had passed more than forty summers before he had earned for himself the reputation of being the world's premier mystifier in the exclusive art of handcuff manipulation, of his period. Howard Thurston, who at this time is touring the country with the largest presentation of magic and illusions, did not begin to harvest the fruit of his efforts until rather late in life. To obtain fame and fortune in the world of conjuring seems to be one of the most difficult of achievements known in the field of any of the many professions. The "Greats" of the past were all men in whose head the gray had begun to predominate, before they had earned their position as masters in their chosen fields.

Harry Kellar, Alexander Herrmann, Robert Hellar, Anderson, the Wizard of the North, and other such names that are paramount in the pages of magical history, may authentically be added to this list. Yet no man in the entire history of mystery entertainment, has earned the vast amount of publicity, and world-wide recognition, that Dunninger can boast of.

This ambitious young artist has entertained more celebrities than any other entertainer in his particular line. Among these might be mentioned the late President Theodore Roosevelt, the late President Warren G. Harding, ex-President William Howard Taft, ex-President Calvin Coolidge, and H. R. H. the Prince of Wales. Many gala society functions have programmed the appearance of Dunninger, and the smartest parties throughout the United States have been arranged with the exclusive purpose of giving the friends of the hosts an opportunity of witnessing the unique demonstration of thought transference and Indian conjuring, in which Dunninger specializes.

Dunninger has always been interested in mindreading and mental telepathy. He frankly admits that he possesses no

Below — Clipping from *The New York Telegram* telling of a typical Dunninger exploit


THE NEW YORK TELE

Joe Dunninger Shatters Peace of Ghost Seance

Friend of Harry Houdini Offers $21,000 to Slater, Hailed by Spiritualist General Assembly as "Greatest Medium of All," for Answers to Two Questions in Sealed Envelope.

John Slater, who in the expressed belief of the General Assembly of Spiritualists, is the greatest medium of them all, had the spirits well under control last night. At the Pennsylvania Hotel they were answering the questions of any who might come along and pay his $1, his $1.50 or his $2.

But Slater, who, as related by the same assembly, left home at the tender age of 20 because his family thought him crazy when he "heard voices," reckoned without an old enemy. Not Satan, whom love will overcome, but Joe Dunninger.

Houdini's Friend Pipes Up.

Joe, who used to be associated with Harry Houdini in exposing mediums, went to the meeting. He paid $1.50 and got a good seat. So did four of his friends. They listened while Slater delivered spirit messages to young and old, black and white.

Then Joe, who prefers to be called "just Dunninger," spoke up. His voice wasn't particularly gentle and he was waving his arms. The thirty-third annual state assembly sat up.

the Hanover Central Bank. He waved it aloft, and he waved the envelopes, both with big red wax seals.

Medium Loses Calm.

It was then that the spirits almost deserted the gathering of 3,000—there was standing room only in the grand ballroom. Physical action seemed forthcoming. Slater's cohorts moved on Dunninger. Dunninger's friends stood up.

Slater, who had just been preaching the advantages of calmness and love, seemed to lose both for a moment. Dunninger left protesting. He offered to duplicate any "spiritual" feat performed by Slater.

"It's not the same, though," he protested. "Any one who takes money to talk to spirits for you and—" Dunninger was spluttering.

"He's a vulture," he flushed with heat.

Will Continue Tonight.

Slater, surrounded by admiring cohorts, had regained love and peace, however. He will continue tonight.

"And, my dear people, there will

Behind Hour

Courtesy National Broadcasting Company

Artist Ricca's impressions of a mind reading demonstration

supernatural powers, and that all of the weird things he accomplishes are but the outcome of constant study and practice. Yet, to the layman who has viewed his remarkable demonstrations, this is hard to conceive. In his school days, he could call the answer to a mathematical problem without following the usual essential routine of working out an example. When his 'phone would ring, he was often said to be able to tell who was on the other end of the wire, before lifting the receiver. Yet in spite of the fact that this odd freakish mental condition afforded him amusement, he sought to delve further into the depths of kindred mystic subjects.

He studied the arts of the East Indian wonderworker, as well as the methods of the European magicians, and, having been a great admirer of the late Harry Houdini, he was not to be outdone in this branch of the profession, and also studied the methods of self-liberation. Dunninger has among his hundreds of scrap books one in particular that he fondly treasures. This contains one hundred and sixty-five letters which have been given, after a successful challenge release, and signed by chiefs of police and prison officials in various parts of the globe.

Dunninger would enter the warden's office and defy him and his aides to place him in a cell from which he could not liberate himself. He would be stripped of his clothing, thoroughly examined, and after being securely shackled and handcuffed, would soon find himself locked behind the bars of one of those dismal cages of confinement. As a rule, it would take this young wizard but two or three minutes before he would again re-enter the warden's office, fully dressed, and holding the opened shackles in his hand. Escaping from packing boxes, water filled tanks, straitjackets, etc., was also part of Dunninger's routine, and although he soon discarded this work from his repertoire, he still possesses one of the largest collections of restraint implements and handcuffs in the world. The pillories, antique irons, and special devices used as far back as the Spanish Inquisition are included in his collection that numbers into the thousands.

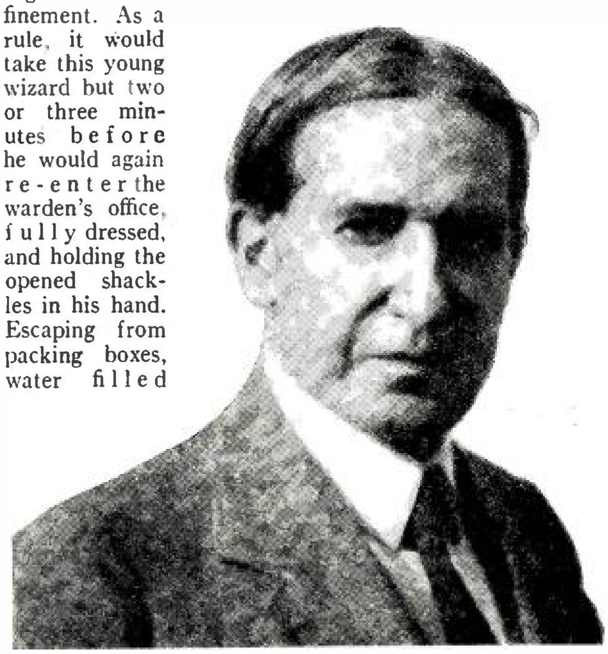
His knowledge of the magicians' art has also been attained by practical experience, judging from the fact that at the present time he has over three hundred illusions in his storehouse, many of which have been used by famous magicians, past and present.

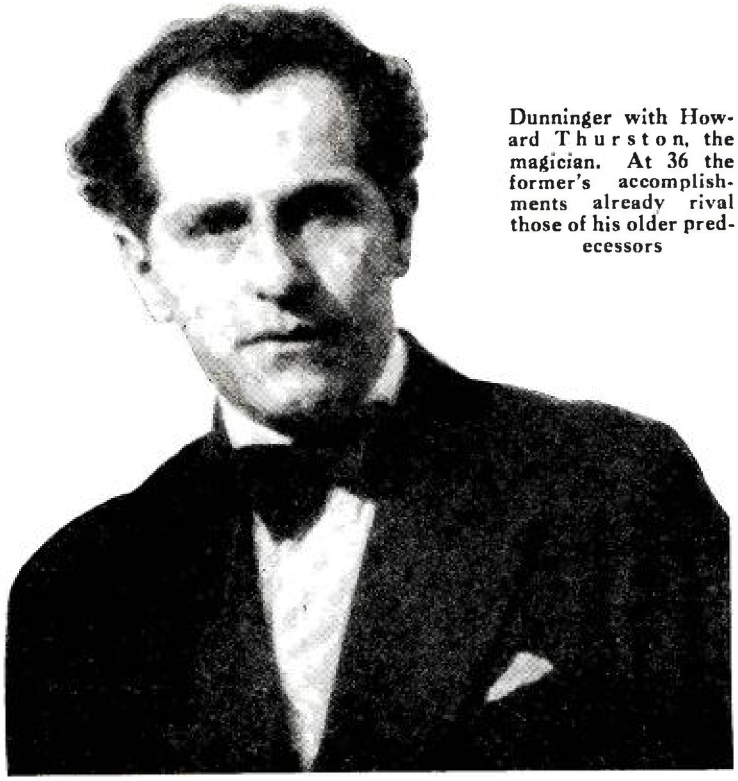
In this collection is one particular effect that is known the world over. This is called the Automaton Psycho. Many years ago this illusion was purchased by the late Harry Kellar, from Maskelyne and Devant in England. It changed hands, and became the property of Charles Carter, Howard Thurston, back again to Kellar, and then to the late Harry Houdini.

Dunninger offered Houdini $1,500 for this effect, but was smilingly refused; yet when the latter died, his friend was agreeably surprised to find that Houdini had made provision so that Psycho would be passed on to him.

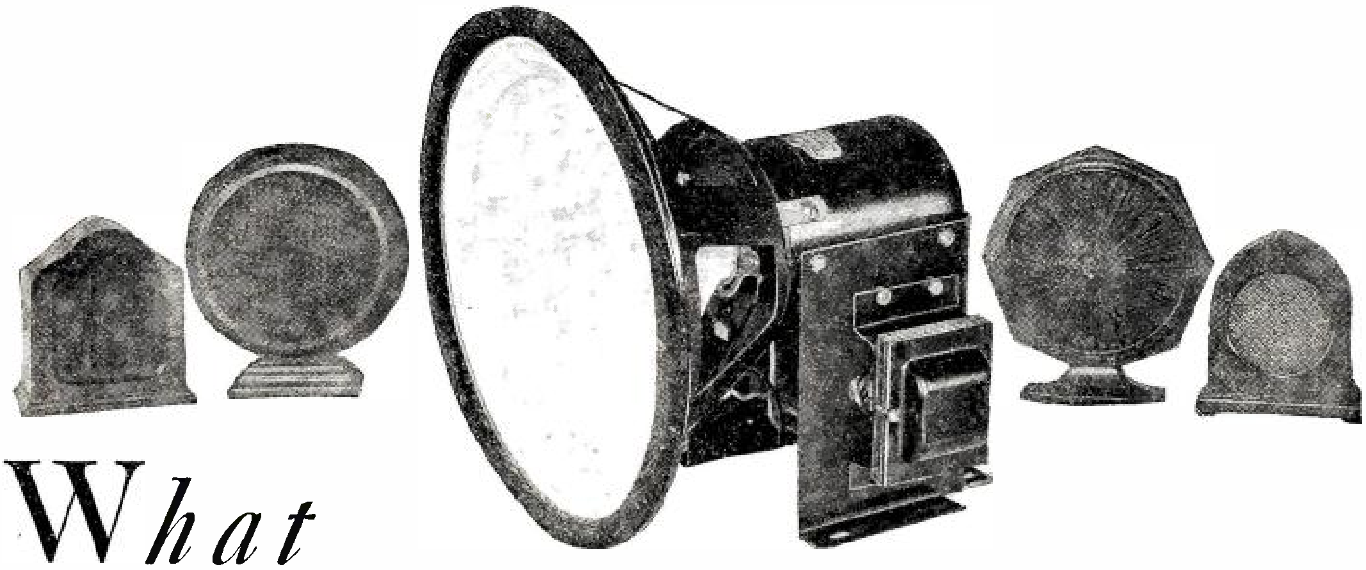
Psycho consists of a small Arabian figure, which rests upon a glass cylinder.

(*Continued on page 358*)





Dunninger with Howard Thurston, the magician. At 36 the former's accomplishments already rival those of his older predecessors



What Is A Good Loud Speaker?

A Discussion of the General Types of Reproducers With Special Treatment of the Dynamic

By James Martin

THE loud speaker is but one link in the chain that connects the broadcasting station with the listener in his home. It is no more—or less—important than any of the other links. In the radio chain between the artist's voice and our own ears there are microphones, transformers, wire lines, the ether, a loud speaker, batteries and tubes; defects in any one of them can ruin a program. Considering all the possibilities for distortion, the excellent quality that a good radio installation can supply is really remarkable. It is indeed fortunate that, unlike a woman, electrical apparatus is not fickle. Once put in good condition it will with ordinary care remain in such condition for a long time (referring of course, to the electrical apparatus and not the woman.)

Most of the larger broadcasting stations transmit excellent quality signals. There is no reason why every experimenter with a good tuner and a good audio amplifier should not be able to listen to excellent reproduction—provided of course that he has equipped his set with a good loud speaker—one that is capable of reproducing most of the audio frequencies with uniformity and without any serious distortion. Of all the links in our chain it is probable that, generally speaking, the loud speaker is the weakest. For this, if for no other reason, the greatest of care must be exercised in its selection. Because the loud speaker is so important we have devoted this article to a discussion of it, pointing out what requirements it must meet and something of how to judge loud speakers with the hope that it will perhaps help the home constructor and experimenter to obtain maximum enjoyment from his hobby—radio.

In the first place, what is a loud speaker? It is a machine. And its function is to take the electrical energy which it obtains from the radio receiver and convert this energy into sound. This it does through the medium of the diaphragm which, vibrating in the air in accordance with the variations in the electric currents passing through the coils, produces variations in air pressure. When these variations in pressure strike our ears they cause small membranes in our ears to move and we hear a sound.

The Perfect Loud Speaker

What would be the characteristics of a perfect loud speaker? In the first place, a perfect loud speaker would reproduce all the frequencies over the entire audio-frequency band which extends from say 15 cycles up to about 12,000 to 14,000 cycles. It would reproduce all these fre-

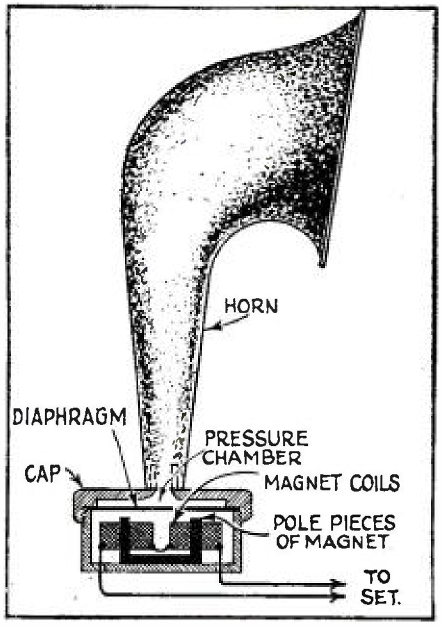


Fig. 1. The first types of loud speakers were nothing more or less than a phone unit with horn attached to ampilfy the sound

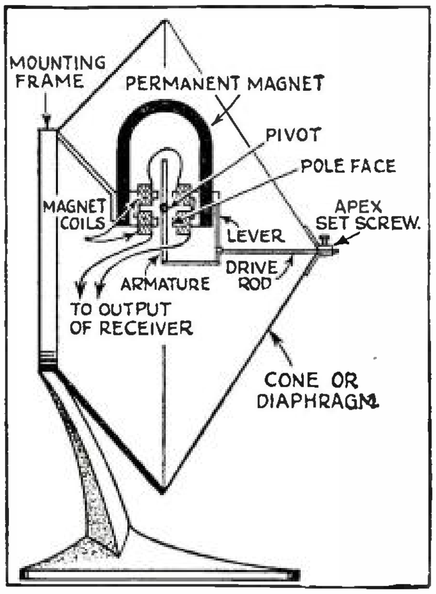
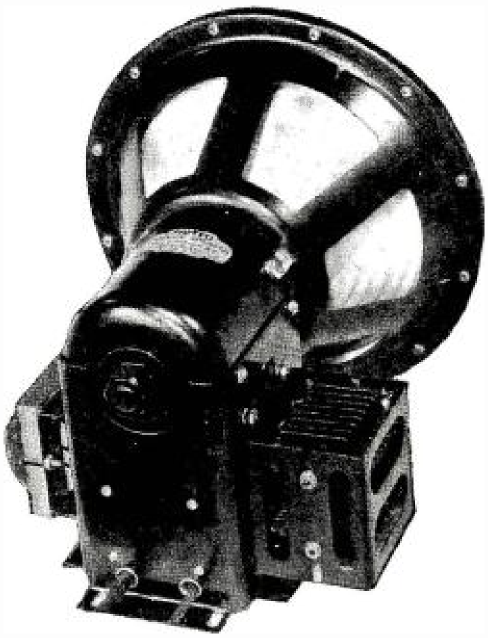


Fig. 2. Cone loud speakers employ in general a driving mechanism similar to that shown here. The entire cone acts as a diaphragm

quencies without discrimination, in other words a response curve of its performance would be "flat" over the entire band. The perfect loud speaker would introduce no new frequencies; that is, if supplied with a pure 60-cycle current it would produce a pure 60-cycle note and not a complicated tone consisting of some 60 cycles and also some of the harmonics of 60 cycles. It would be capable of handling the maximum desired volume without distortion due to overloading or rattling. It would be efficient, converting all or nearly all of the electrical energy supplied to it into sound. It would have a very long useful life and be not in the least affected by dampness or other atmospheric conditions. Does anyone know of a loud speaker that meets all of these requirements? I don't.

Fortunately the loud speaker we use doesn't have to be absolutely perfect to produce very good results and make listening to radio an enjoyable pastime. The problem is how far the practical loud speaker can depart from the ideal and still be satisfactory. The range of audio frequencies extends, as previously indicated, from about 15 to 14.000 cycles, but the problem is to decide how many of the low frequencies and how many of the high frequencies can be eliminated before serious distortion results. Competent authorities feel that essentially perfect reproduction can be obtained in the frequency band between 30 and 10.000 cycles, the elimination of all frequencies above and below these limits causing no noticeable change in quality. Further it has been found that cutting the frequency band from 10,000 down to 6.000 or 7.000 cycles produces but a very slight change in quality—a change that can only be detected by a direct comparison between the original and the reproduction.

As a result of many practical tests it has also been found that a variation of three to one in the response characteristic is practically negligible and the variations of five to one are not especially important.



A dynamic speaker, showing coupling transformer and dry rectifier

Practical tests have also shown that a distortion of five percent is also not noticeable. A practical loud speaker can be quite inefficient. for the efficiency does not effect the quality and simply necessitates that we must supply the loud speaker with more power for a given volume of sound. Present day loud speakers are characterized by very low efficiencies. Probably the best of loud speakers are one or two percent efficient: that is for very 100 units of electrical energy supplied to them they only produce 2 units of sound. If loud speakers could be made ten times as efficient as at present probably we could all throw away our power tubes!

In summary therefore we can say that a loud speaker. to be "practically" perfect should reproduce the band of audio frequencies between 30 and 6.000 cycles. that the amplitude distortion should not be greater than about three to one. that the harmonic distortion should not be greater than about five per cent and that. although high efficiencies are desirable. quite low values of efficiency are not especially disadvantageous since sufficient power to make up for the low efficiency can easily be obtained from ordinary power tubes.

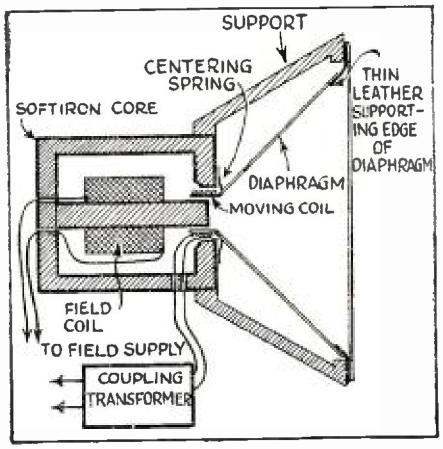


Fig. 3. Herewith is shown the general arrangement of the various parts of a dynamic speaker. Compare it with that shown below

Several Types of Speakers Now in General Use

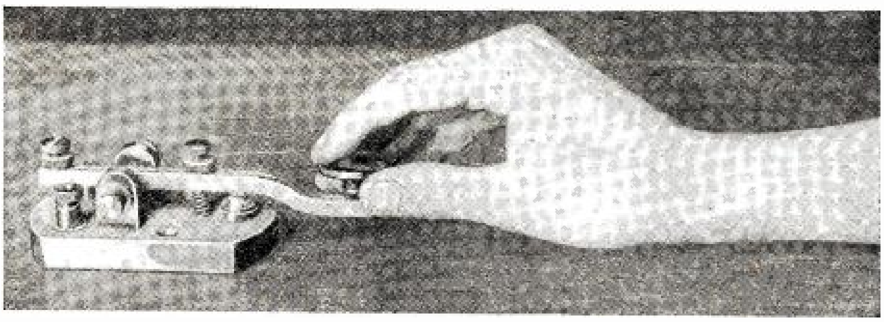
Loud speakers have been made using a large variety of principles but most of them have proven impractical for one reason or another. All loud speakers in use today (with the exception of the condenser loud speaker) depend for their operation on magnetic forces. The three types of loud speakers now in general use are the horns, Fig. 1, cones using balanced armatures, Fig. 2. and dynamic loud speakers. Fig. 3. which are cones driven by a moving coil. The two former types. *i. e.* horns and ordinary cones. have definite limitations. Horns, unless they are of the exponential type and very large are definitely limited in frequency response. A newcomer in the loud speaker field is the condenser speaker of which more will be heard of in a following article.

Probably the outstanding example of a good balanced armature type loud speaker is the Western Electric cones, types 540 and 560. These loud speakers. especially the 540 and similar cones made by other manufacturers, were exceedingly popular and have experienced competition only lately by the introduction of the dynamic type loud speaker. The balanced armature type of loud speaker drive is arranged as indicated in Fig. 2. It consists of a permanent magnet. M, with four pole faces arranged adjacent to the armature. The armature is balanced between the pole pieces and around the armature is wound the coil which is connected to the radio set. The audio-frequency currents from the output of the set. passing through the coil, caused it to move in the space between the pole pieces. In so moving it of course carried the diaphragm with it and the movements of the diaphragm produce a movement of an air column thus causing the sound. Well designed balanced armature type loud speakers are capable of giving quite excellent results although they have several quite definite defects. among which are magnetic saturation. limited movement, resonance in the armature and driving pin. varying impedance characteristic, etc., and these are sufficient to definitely limit the results obtainable from this type of loud speaker. The better cones of the last two or three years were probably as good as could possibly be obtained consistent with reasonable cost. In a certain sense therefore the dynamic loud speaker was forced into existence because of the limitations of other loud speakers—the art had to advance and in the case of loud speakers some fundamental change was necessary to permit this advance.

To give the cone of this dynamic a degree of rigidity, it is serrated, as shown in the battery-operated dynamic above

The dynamic speaker, with which this article will mainly concern itself, works on principles quite different from those found in the balanced armature type although in both cases magnetic forces are involved. Because the dynamic loud speaker is rapidly replacing both the horn and the ordinary cone. being capable of giving much better results than either of these types. we will devote considerable space to an examination of the design of dynamic loud speakers. After all a loud speaker. even the best. is simply a number of pieces of metal, paper. fibre and wire and it is useful to know how these

(*Continued on page 368*)

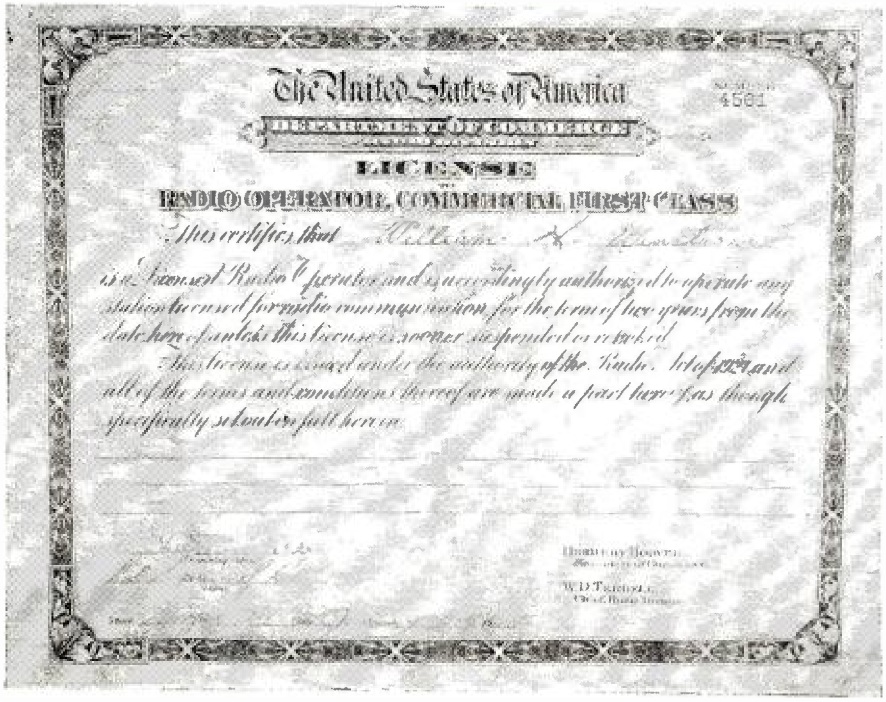


Breaking *into* Amateur Transmitting

By Lieut. William H. Wenstrom, U. S. A.

LAST month we traced at some length the absorbing story of Amateur Radio; we now consider some of the practical problems which confront an entrant into the transmitting fraternity. First of all, let us forget any lingering hostility which we may feel towards code—the dot and dash signals of radio telegraph stations. Once fairly learned, code is not at all the stupid, meaningless collection of symbols that it appears to outsiders. Ruling out machine and "bug" sending, an unbelievable amount of personality trickles through the sending of an individual, however measured he may strive to make it. We can easily classify experts and dubs—can even recognize quickly an operator with whom we have talked before. No two humans are exactly alike, and tricks of spacing and tempo mark an individual as surely as his manner of parting his hair. Strange as it may seem, it is almost as hard to keep the emotions out of code as out of the voice; timidity and anger both have their dot-dash rhythms.

The Department of Commerce of the U. S. Government issues to all who satisfactorily pass the required tests a license similar to Lieut. Wenstrom's, shown here


The United States of America
No. 4561
Department of Commerce
LICENSE
RADIO OPERATOR, COMMERCIAL FIRST CLASS
This certifies that William H. [illegible]
is a licensed Radio Operator and is accordingly authorized to operate any station licensed for radio communication for the term of two years from the date hereof unless this license is sooner suspended or revoked.
This license is issued under the authority of the Radio Act of 1927 and all of the terms and conditions thereof are made a part hereof as though specifically set out in full herein.
Herbert Hoover
[illegible]
W. D. Terrell
[illegible]

Manners and consideration for others, or the lack of them, are as evident on the air as they are on the road. We have all blessed the driver who put out his hand a few seconds before he turned, or realized our momentum along a highway well enough to refrain from crawling out of a side street directly in front of us. And we have all cursed the man who turned directly in front of us with little if any warning, or passed us in a burst of speed only to slow down immediately. The latter individual's counterpart on the air is characterized by a sputtering, wobbly note, too-rapid and unintelligible sending, and scarely anything to say except "hows mi sigs? rpt my sig strength—pse send card—cul gb." When we come back with "hr msg air transport emergency," he greets us with a profound silence only to be broken by a sputtering "cq" for somebody else. But this type is fortunately a very small minority—else all cars would be wrecked and all transmitters gathering cobwebs. By means of abbreviations two good operators can talk in code almost as fast as they could by telephone. The system is a sort of home-made shorthand wherein unnecessary letters, particularly vowels, are omitted. Weather is wx, press is px, repeat is rpt, thanks is tnx or tks, your is ur, very is vy, please is pse; and so on, ad libitum.

Another distinctive pleasure of transmitting is that two-way communication requires far more skill than receiving. When skill entails work, distasteful to many of us, this statement may seem rather paradoxical; nevertheless, it is a fact, amply proved by observation. The devotees of chess would scarely consider checkers; a hunting horseman has no taste for ambling through the park on a tame nag; good sailormen would be bored to death on a motorboat. The transmitting operator has not only his receiver to think of; the transmitter must be turned on and adjusted for frequency, output, efficiency and steadiness. The wily distant station must be sought among the channels like an elusive deer in the forest, and when it is found, no hunter's trigger finger could be more smoothly certain than the hand that throws the switches and taps the key.

Another advantage of transmitting is greater control over the phenomena, to borrow a phrase from the laboratory. Reception is likely to degenerate at times into a sort of watchful waiting, but the owner of a transmitter can always start something. A well-remembered incident at W2CX occurred during the ill-fated Atlantic flight of Nungesser and Coli. W2CX hopped into the well filled 40 meter conversational puddle with a long CQ and "Any news of Atlantic fliers?" This innocent inquiry was apparently interpreted as a statement preceding the broadcast of important news, for immediately half the stations in New York and New England were heard frantically calling W2CX.

Then, too, phone receiving is somewhat limited in its scope, for broadcast transmitters have a tendency to congregate around the large cities of the world. They seldom go to sea, or essay the air, or take themselves off into remote jungles. But the amateur and experimental code sta-

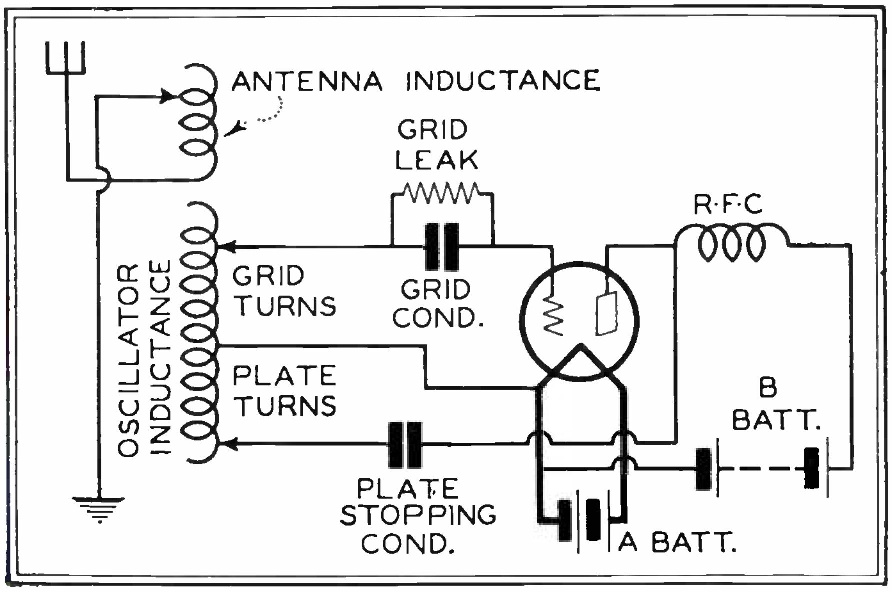


Fig. 1. One requirement of the Government test is to draw the circuit diagram of the transmitter you intend to use

tions are everywhere. Another W2CX red letter occasion was an evening chat with a courteous Englishman up in Cameroons, French Equatorial Africa. It consisted mostly of questions from New York and answers from Cameroons. "Are you on the coast or up in the jungle?—about 100 miles from coast. Is it pretty hot there?—very warm all year round. Are there any lions around there?—lots of game here, both big and small." If the answer had been "there is a big lion looking in the window and roaring now," we would probably have believed it.

Atlantic flights and roaring lions are all very well in their way, but let us get down to business. Several weeks at least before he starts actual transmitting the new operator should have completed the installation of a short wave receiver, both for code practice and for familiarity with the various amateur bands. Just what kind of receiver this is does not particularly matter, so long as it meets certain fundamental requirements. The first of these is ability to go smoothly into and out of oscillation at any frequency within the receiver's range. (A grid biasing potentiometer, as used in the Portable Receiver described in the July issue, is useful here.) Secondly, the amateur band corresponding to any particular coil should be well spread out along the center of the tuning dial. The extreme fulfillment of this requirement is the "traffic tuner" which spreads a single amateur band over the whole dial. Somewhat the same delicacy of tuning with better all around coverage may be gained by connecting a midget condenser (cut down to one stator and one rotor) in parallel with the regular tuning condenser of about 140 m. m. f., as shown in Fig. 1. Another requirement is the ability to change wave-bands quickly, and still another is some form of arm rest for tuning, as shown in the photograph. Distant high frequency stations cannot be snapped in with the casual dial twist that does for broadcast tuning.

Most recent short wave receivers employ a screen-grid radio frequency amplifier tube, and this is satisfactory for rapid two way work (though scarcely necessary with a long outdoor antenna) if no extra tuning controls are added. For searching a band quickly the receiver must be strictly single control (have only one tuned circuit). This does not include the oscillation control, which requires only occasional adjustment.

There are now so many good short wave receivers available that anyone may easily buy or build one. The four commercials — Silver - Marshall, National, Pilot, and Aero—are well designed and dependable. Then there is Samuel Egert's "S-W Four" described in the August issue, of which the detector unit and one audio stage would do very well for amateur work. A general discussion of 1929 amateur receiving requirements appeared in QST for November, 1928. For anyone who wants the utmost simplicity and ease of construction combined with creditable performance, the writer's "Cornet Receiver" described in Radio Broadcast for April, 1928, should prove useful. This set is still in use at W2CX, for nothing in the way of all-around code and phone performance by any newer design has inclined us to discard it.

Code Practice

The greatest bugbear in the way of becoming an operator is undoubtedly mastering the code. There is no absolutely

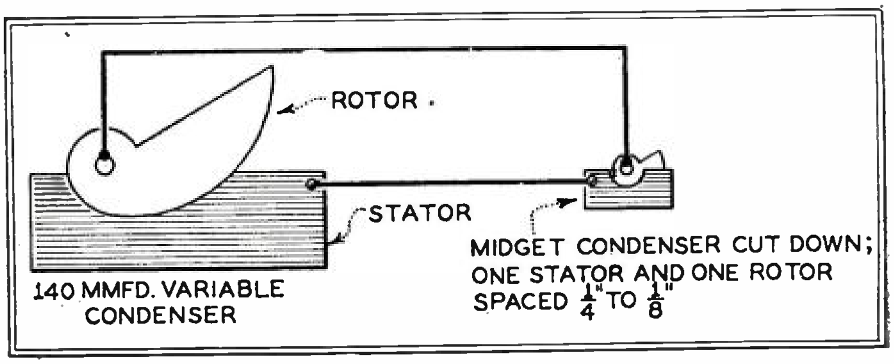
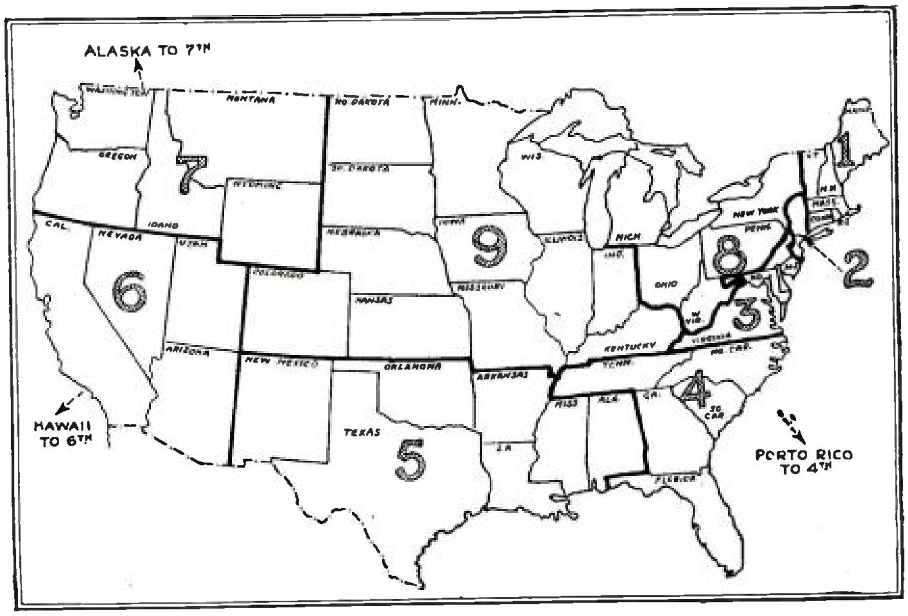
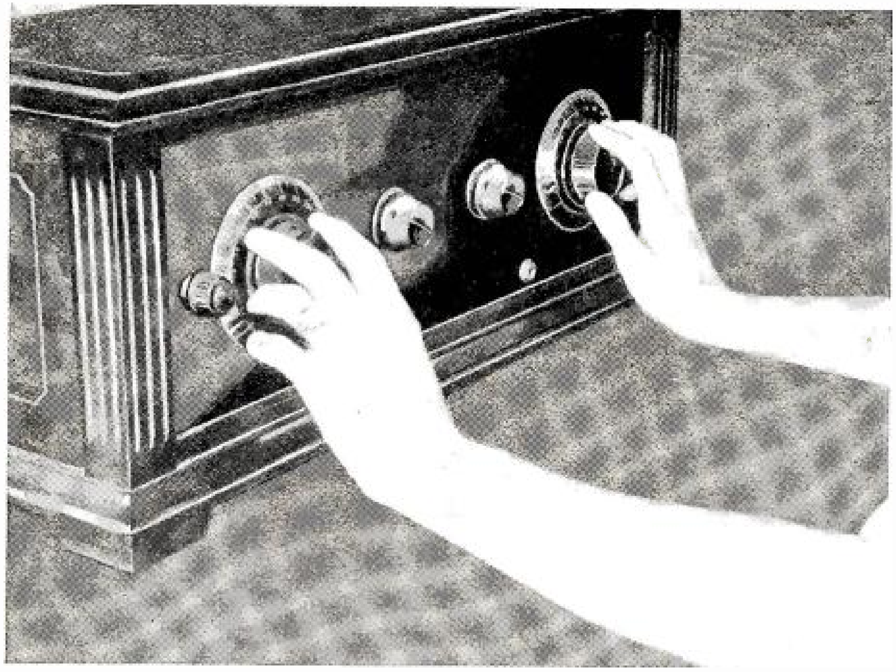


Fig. 2. To obtain a high degree of fine or vernier tuning action, a small condenser may be shunted across the main tuning capacity

Fig. 3. The United States is divided into nine districts, as shown, to facilitate control and regulation of amateur transmitting activities





A firm, substantial rest for the fore-arms is an absolute necessity for distance tuning

THE GENERAL SERVICE CODE

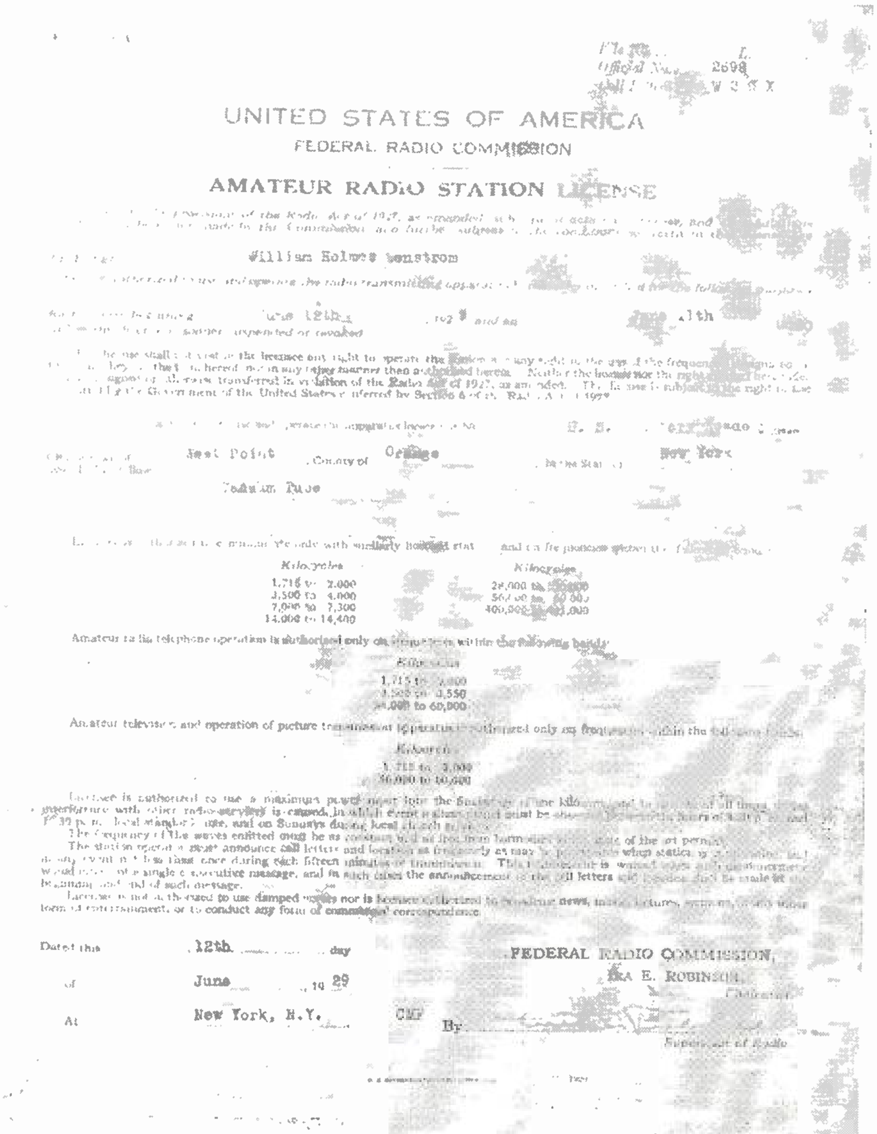
A dit dah
B dah dit dit dit
C dah dit dah dit
E dit
F dit dit dah dit
G dah dah dit
H dit dit dit dit
I dit dit
J dit dah dah dah
K dah dit dah
L dit dah dit dit
M dah dah
N dah dit
O dah dah dah
P dit dah dah dit
Q dah dah dit dah
R dit dah dit
S dit dit dit
T dah
U dit dit dah
V dit dit dit dah
W dit dah dah
X dah dit dit dah
Y dah dit dah dah
Z dah dah dit dit
1 dit dah dah dah dah
2 dit dit dah dah dah
3 dit dit dit dah dah
4 dit dit dit dit dah
5 dit dit dit dit dit
6 dah dit dit dit dit
7 dah dah dit dit dit
8 dah dah dah dit dit
9 dah dah dah dah dit

Time or duration relations:
dah is three times as long as dit
intra-letter space same length as dit
inter-letter space same length as dah
inter-word space two or three times as long as dah

painless way of learning it, or of doing anything else which requires mental effort and concentration. But the process will be easier if two cardinal principles are borne in mind. First, learn each letter as a single unit of sound, rather than as an aggregation of dots and dashes; second, do not hesitate over missed letters but go on to the next. It is much simpler, for example, to write "x" instantly when we hear a "Dah-dit-dit-dah" sound, than to think "dah-dit-dit-dah—let's see, that's dash-dot-dot-dash, and as I remember it, x looked about like that." Therefore eliminate any visual images of "x," such as —··—; the jump from ear to fingers is naturally much quicker than dragging in the visual part of the brain as well. Until you can write down each letter reasonably soon after the sound is heard, it is advisable to have someone send slowly to you on a buzzer, or to use a teleplex or omnigraph. After your speed begins to pick up a little, the short wave receiver offers a more varied and interesting field for practice. It is usually possible to find in one of the bands an amateur sending at a speed you can copy, and sometimes the highpower commercials are slowed down as low as ten words a minute under poor transmission conditions. Along with reception it is well to practice keying. As shown in the photo-

(*Continued on page* 364)

Your station license, when issued, will authorize you to begin your transmitting career


Official No. 2698
W 2 B X

UNITED STATES OF AMERICA
FEDERAL RADIO COMMISSION

AMATEUR RADIO STATION LICENSE

William Holmes Wenstrom

West Point, County of Orange, New York

Kilocycles	Kilocycles
1,715 to 2,000	28,000 to [illegible]
3,500 to 4,000	56,000 to 60,000
7,000 to 7,300	400,000 to [illegible],000
14,000 to 14,400	

Amateur radio telephone operation is authorized only on frequencies within the following bands:

Kilocycles
1,715 to 2,000
3,500 to 3,550
56,000 to 60,000

Amateur television and operation of picture transmission apparatus authorized only on frequencies within the following bands:

Kilocycles
1,715 to 2,000
56,000 to 60,000

Dated this 12th day of June, 19 29
At New York, N.Y.

FEDERAL RADIO COMMISSION,
IRA E. ROBINSON,
Chairman.
By
Supervisor of Radio

The Tube Industry Becomes Big Business

By William F. Matthews

ALMOST over night the tube-making part of the radio industry has emerged from a state of comparative uncertainty to become one of the most stable and promising divisions of the whole enterprise. With starting suddenness radio broadcasting swept over the land and set up a constantly growing demand for tubes. With the electric light bulb industry to offer a basis for manufacture, the infant tube industry got away to a flying start. Now catching up with demand, then running ahead of it; beset with innumerable manufacturing difficulties and the pitfalls caused by an impatient public; remedying its faults as it went along and uncovering still more secrets locked in the depths of refinement — these and many other influences presented themselves for the industry to hurdle. From the laboratory in a small bedroom to the mammoth tube manufacturing plants of today with untold millions of capital invested; from nothing at all to sales approaching $150,000,000 annually with many more millions in sight—that, my friends, constitutes the swift growth of the radio tube business, in but a few years.

There are at present more than fifty manufacturers engaged in making radio tubes. The products of the majority of these manufacturers are really high-grade, although those enjoying the best of research facilities and the capital to put refinements into production naturally are in a better position to turn out better products. And yet some of the most notable advances in tube construction and performance have emanated from the laboratories of manufacturers not so favorably situated. Genius follows no prescribed nor dictated path.

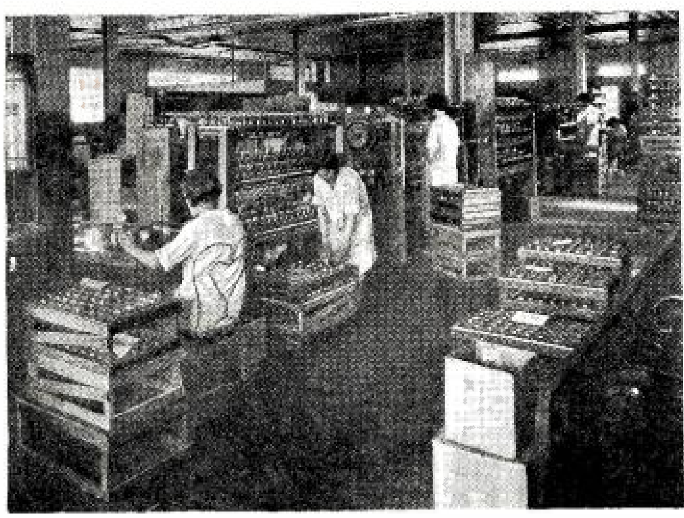
The capitalizations of these tube companies range all the way from a few thousand dollars to many millions. The majority of the companies are closely held, having been financed by a few individuals. Several, however, enjoy listing on various stock exchanges and thus serve as an index of the business. Moreover, a surprisingly large number of the tube companies, both publicly held and otherwise, are making money. The income from tubes constitutes the bulk of the earnings of the Radio Corporation of America, although no definite figures are available. Many of the so-called independents, such as Ceco, Triad, Sonatron. Sylvania, Gold Seal, Marvin, Arcturus, Van Horne and a host of others, derive their sole income from the sale of tubes and many of them are in a flourishing and expanding condition. Conceivably, tube manufacturing may be overdone, and yet it may be several years before retrenchment will set in. That the industry is bound to go through successive corrective stages no one, save possibly an over-enthusiastic manufacturer, will deny; and then he will most likely pay the penalty of his enthusiasm.

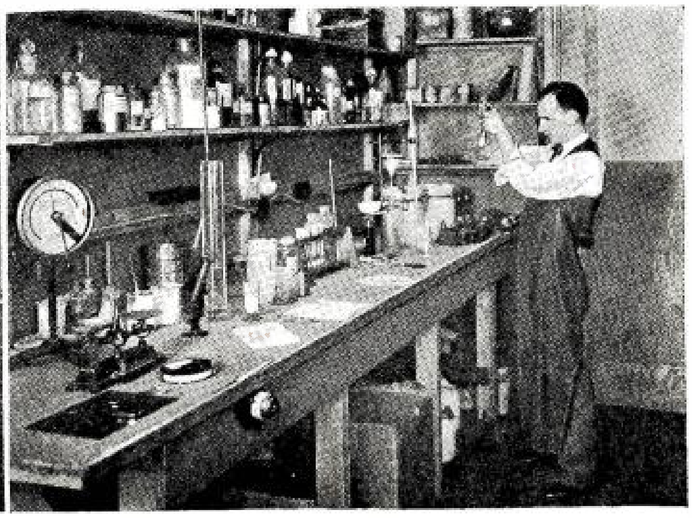
Where Is the Saturation Point?

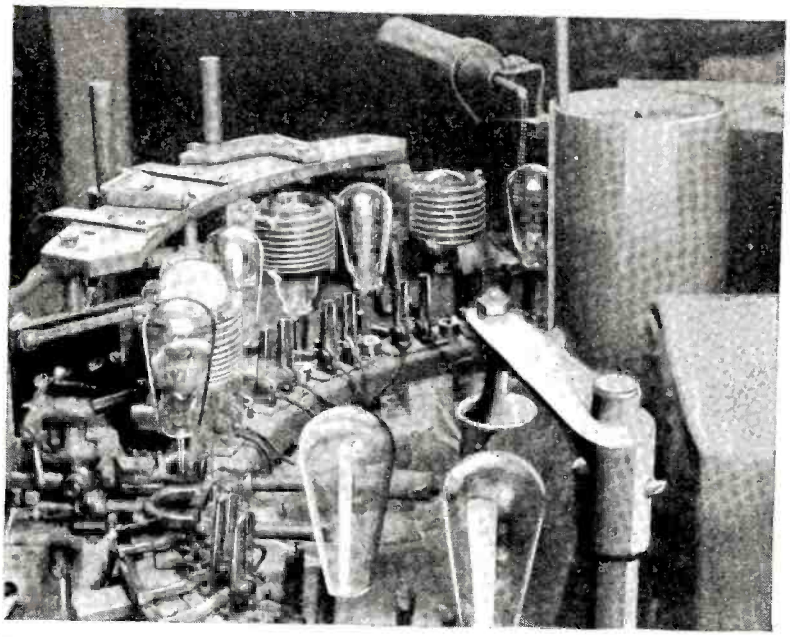
According to figures compiled by the Department of Commerce, the saturation point in radio is far, far away. It has been estimated that only one-third of the homes throughout the United States possess radio receiving equipment, and throughout the world the percentage is exceptionally small. Add to this the fact that the world never yet has caught up to the mythical saturation point on any product that is good.

To begin with, we had a radio tube. Now we have radio tubes. In the early days of the radio novelty era, any screech or howl that came through the loud "squeaker" sufficed. Then began the quest for quality coupled with sensitivity. Tubes influenced radio design and quality of condensers, transformers and such like influenced the output of tubes, and the whole was dependent on what the loud speaker was willing or able to interpret. Radio reception was faced with a whole array of handicaps, the principal one of which was the inflexibility or the inability of *the* radio tube to work satisfactorily as a radio frequency, intermediate frequency or audio frequency amplifier and rectify the incoming signals as well. And so the problems of designing suitable tubes for

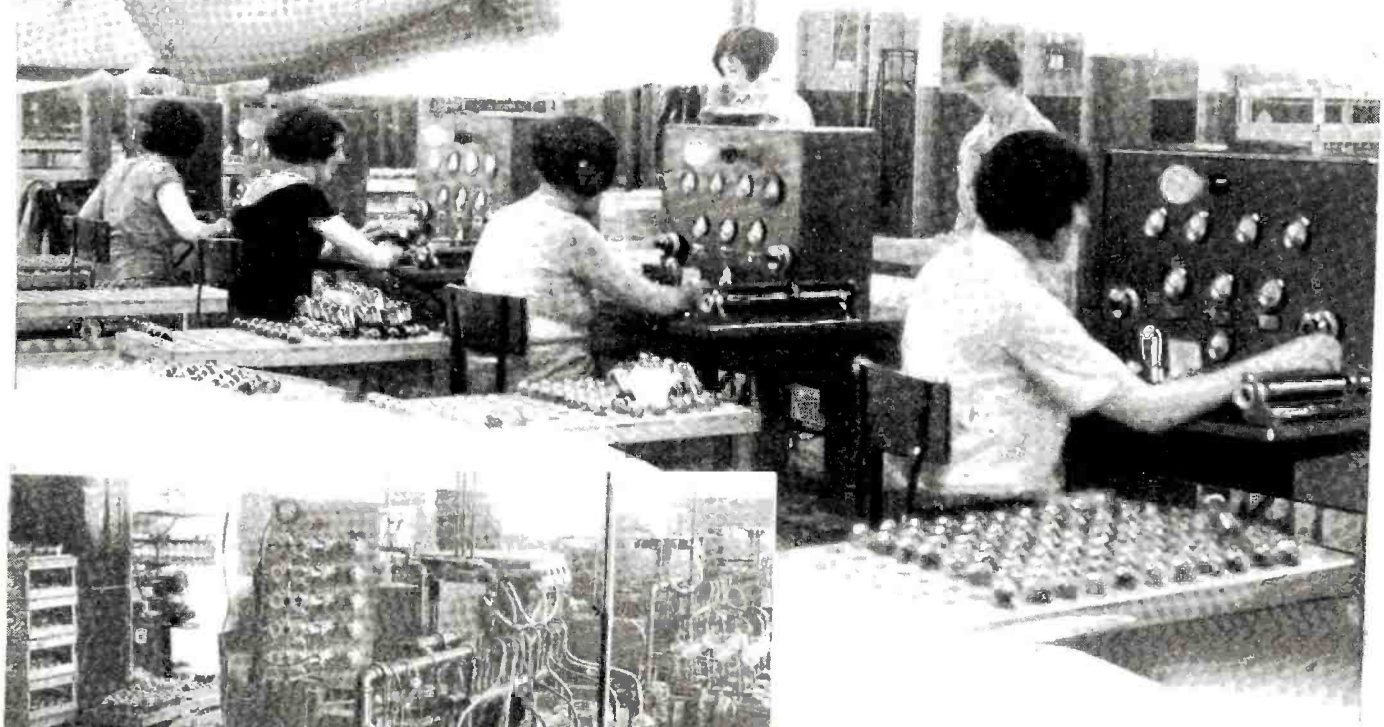
Courtesy Cable Radio Tube Corporation

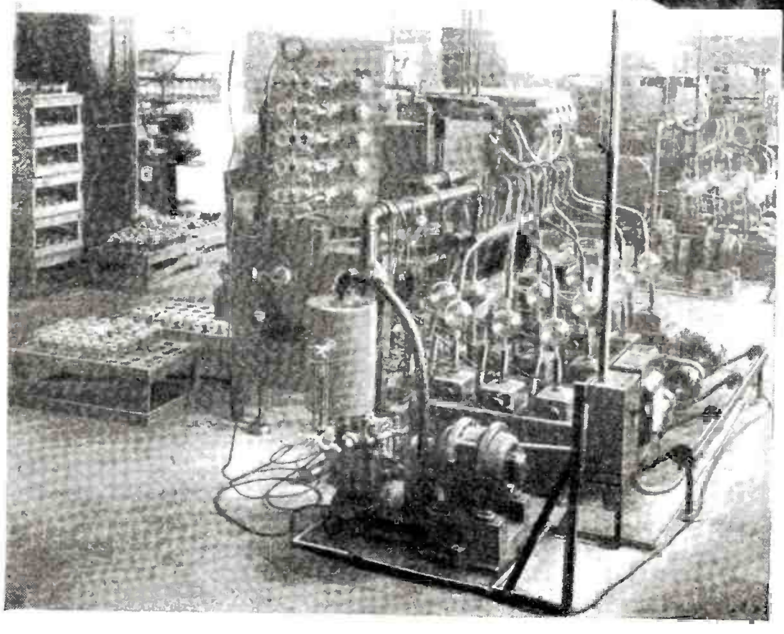






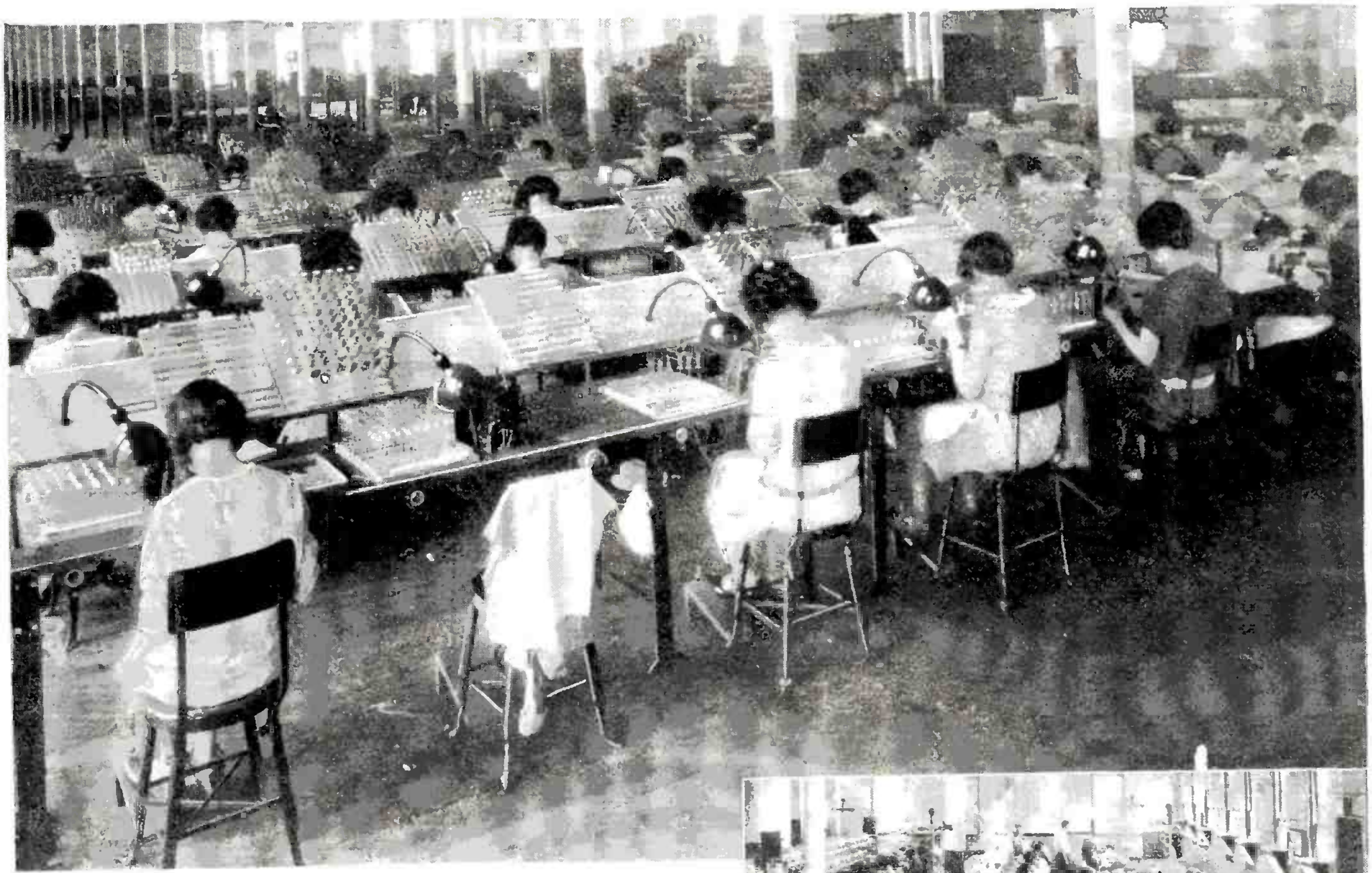
Photographs on these two pages by courtesy of Sylvania Products Co., Duovac Radio Tube Corp., Triad Mfg. Co., Inc., Ceco Mfg. Co., Inc., R. C. A., National Carbon Co., Cable Radio Tube Corporation

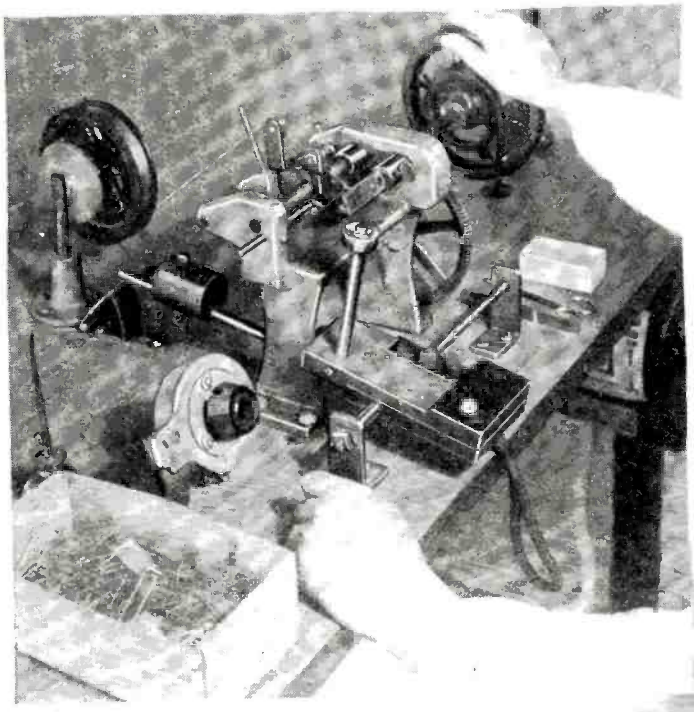


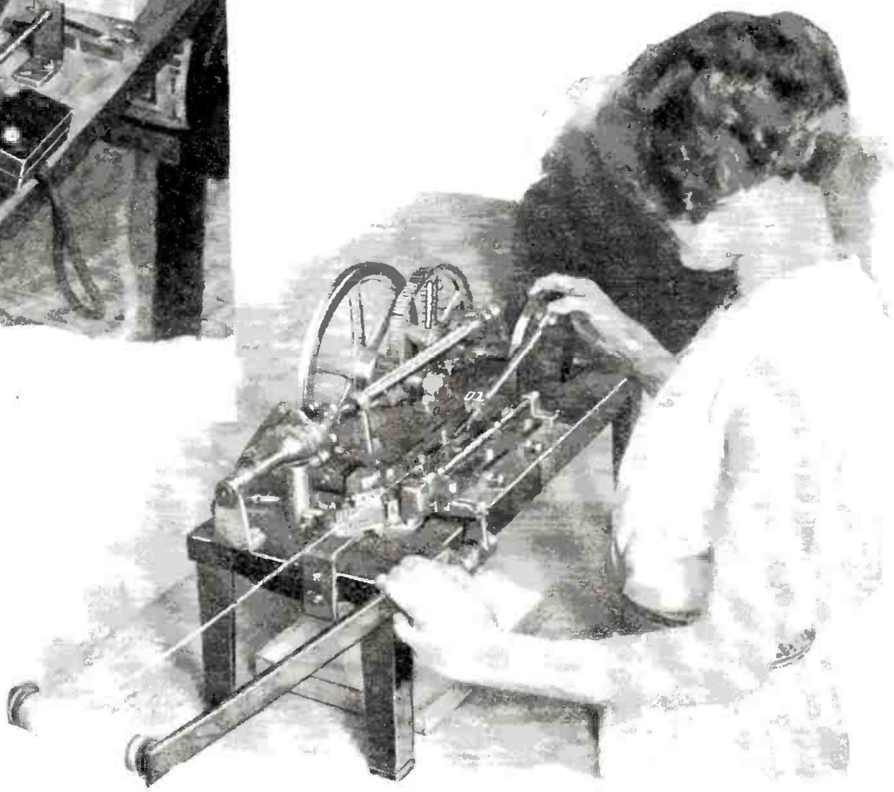


each position in a receiver got definitely under way. That marked the beginning of a financially successful day for radio.

Note what happened to the tube sales in 1928, the year that saw the introduction (in volume) of the a. c. tubes. Sales jumped nearly double over 1927 (from $67,000,000 to about $112,000,000) and the full buying power of the public, as measured from the standpoint of the replacement of battery-operated tubes with the a. c. types, had, at the end of 1928,







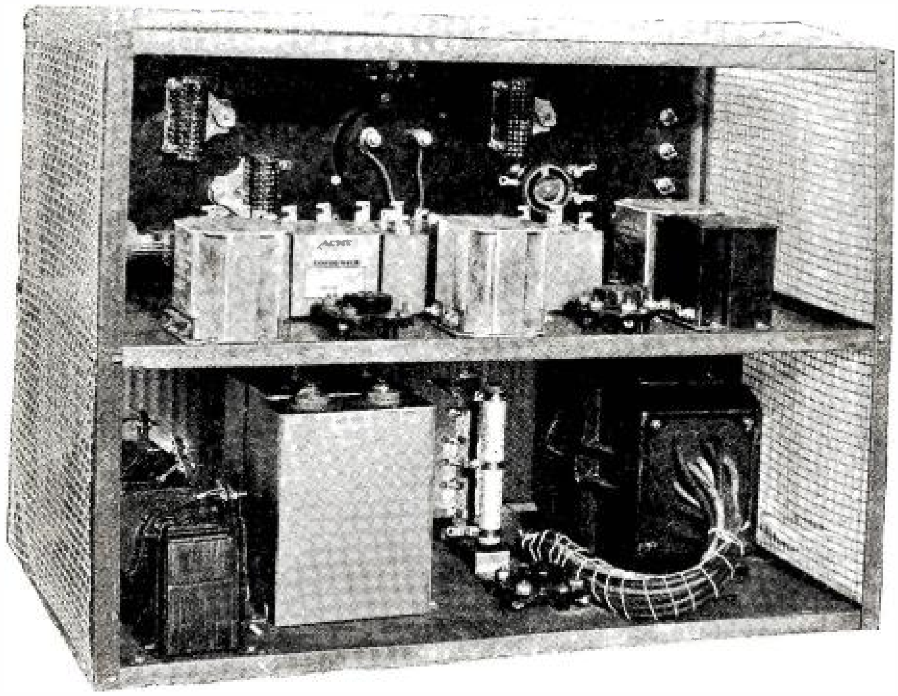
scarcely gotten under way. With production of receivers well under way, with orders from dealers mounting on the manufacturers' books, and bearing in mind that an average of six tubes is required for each new receiver, and the further fact that replacements form the basis for even more tube sales, it will probably not be difficult to see that the future opportunities of the tube-making industry may be numbered among the great.

This COMPACT FLEXIBLE SPEECH AMPLIFIER

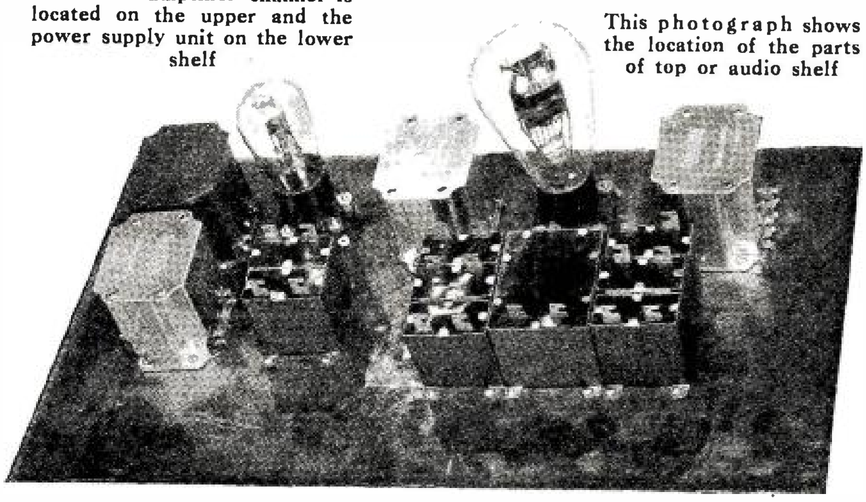
Provides a New Source of Income for the

Radio Serviceman

By S. Gordon Taylor



The audio amplifier channel is located on the upper and the power supply unit on the lower shelf



This photograph shows the location of the parts of top or audio shelf

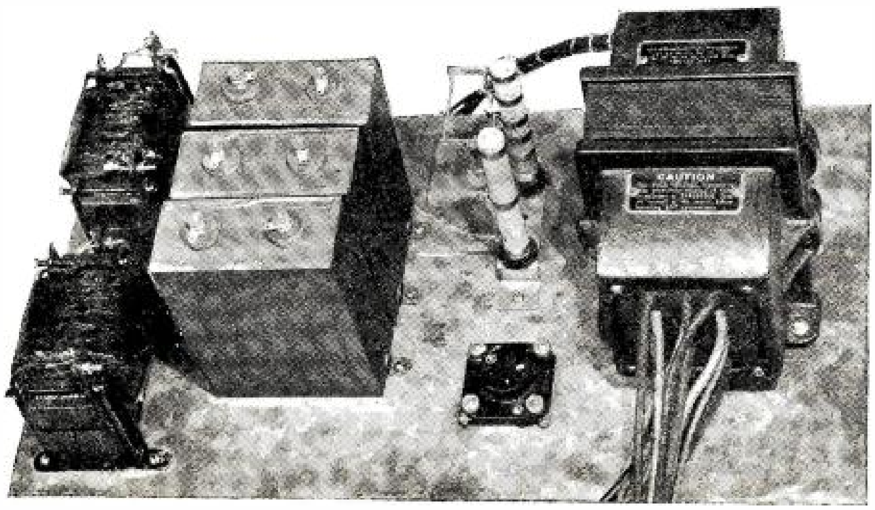
READERS who have been following this series of articles will remember that in the first article, which appeared in the August issue, a suggestion was made that those entering the sound amplifier installation field can best start with a small job in order to become familiar with the requirements for this type of service. It was further suggested that a great deal of useful technical knowledge could be obtained by assembling the entire amplifier and power supply equipment for the first job or two. The idea behind this suggestion was that power amplifiers for use in stores, hotels, amusement places, etc., differ somewhat in detail from those ordinarily employed in the home.

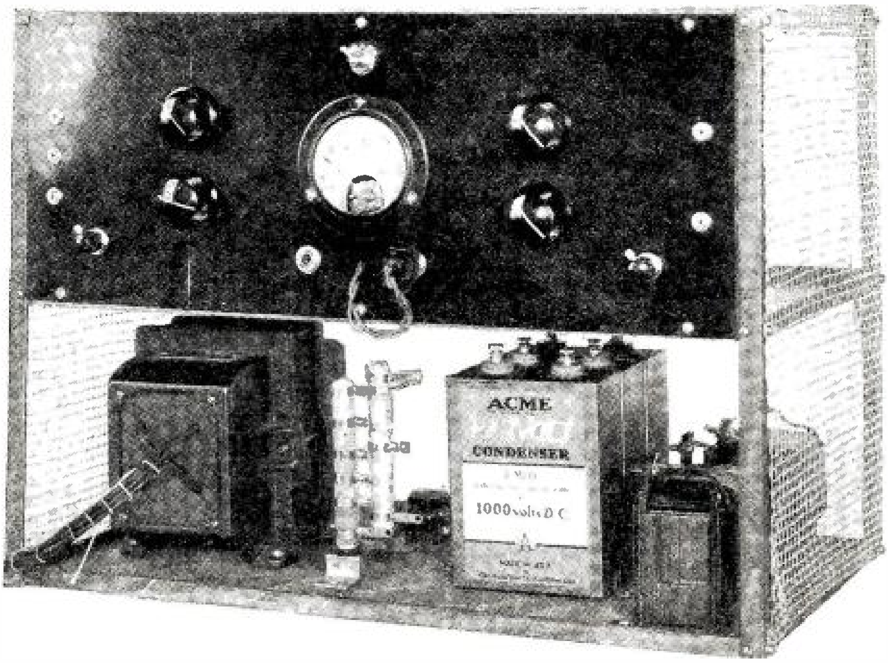
The experience gained in building one of the commercial type should prove helpful when for later jobs it is desired to select manufactured equipment. Moreover, the detailed knowledge of every function and part of the equipment makes the installation man better able to cope with any emergencies that may arise in installations employing standard manufactured equipment.

With the foregoing idea in mind, this third article of the series is to be devoted to a description of a complete power amplifier unit, especially designed to meet the requirements of commercial service. This unit is intended for installation where the volume and the coverage desired do not require such a high power output as could be supplied by a push-pull 250 job, but where more power is required than can be provided by the average radio receiver which does not employ an external power amplifier.

This description is not offered as a standard to be followed in exact detail for all medium sized installations. While it will probably serve to excellent advantage in the majority of such cases, it will in others require some minor changes

Here is shown the layout of the power supply parts on the metal base plate





All controls are easily accessible, being mounted on the panel. A wire screen covers the lower front

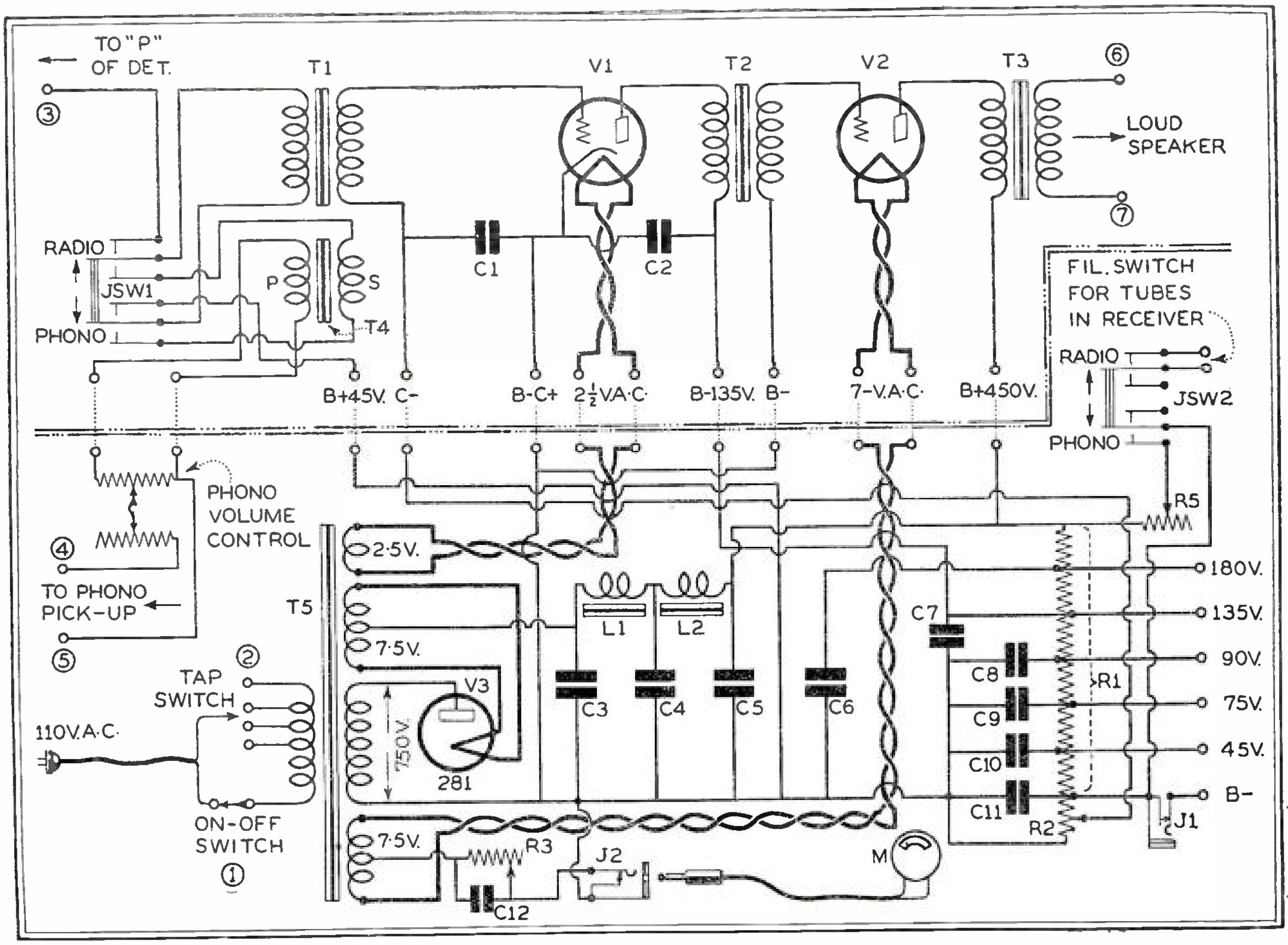
to adapt it to the particular requirements of a given job. In any event, the description will serve to point out some of the special requirements called for by equipment which is to be used in commercial service. So far as the writer knows, some of these special features have never been included in descriptive articles published heretofore.

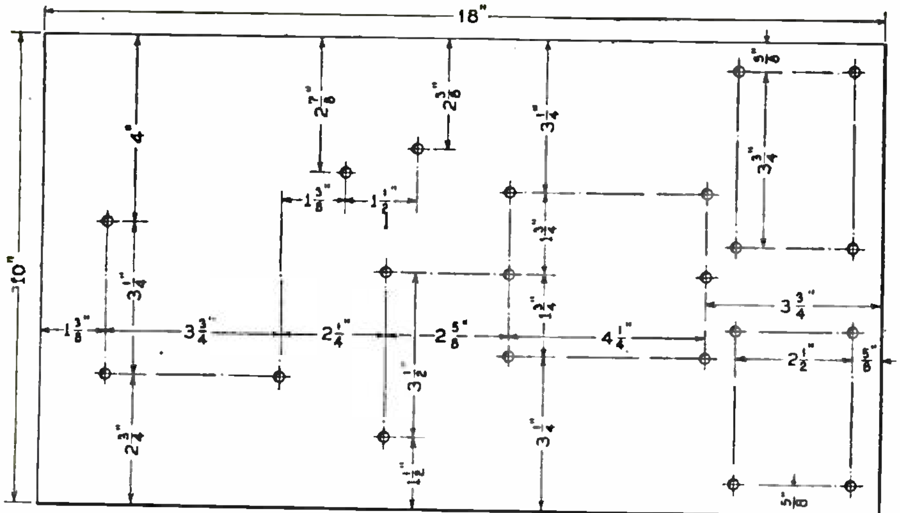
Commercial amplifiers, a convenient term to distinguish equipment used in schools, hotels, etc., from that ordinarily employed in the home, involves special considerations. One of the first requirements is that such equipment be made foolproof, because in almost every case it is to be operated by someone who knows nothing about its technicalities. Obviously, the owner wants to feel that he can expect continuous service without the necessity for calling in a service man every week or so. Every trouble-free installation serves as a good advertisement for the installation man, whereas frequent breakdowns on one installation may provide unfavorable publicity which will be hard to live down.

Local and Underwriters' Regulations Should Be Observed

The second main requirement is that the equipment be so designed and constructed as to eliminate all fire and accident hazards. This is a most important consideration and one which has received too little attention heretofore in radio and amplifier installations. It is considered so important that the National Board of Fire Underwriters are now formulating definite requirement standards. Final requirements have not been released as yet, but some of the tentative rules have been published, and in designing the amplifier described below, these tentative requirements have been kept in mind. In this connection it is suggested that installation men consult local boards or building inspectors to determine any special local requirements that may exist. Some of these agencies have formulated very definite standards which must be followed.

The complete schematic circuit of the speech amplifier, power supply device. By means of the switches shown, ready changeover from radio to electric phonograph is possible





This is the lower shelf drilling template for the power and filter apparatus; all holes are drilled with a No. 28 drill

Unique Constructional Features Embodied in Design

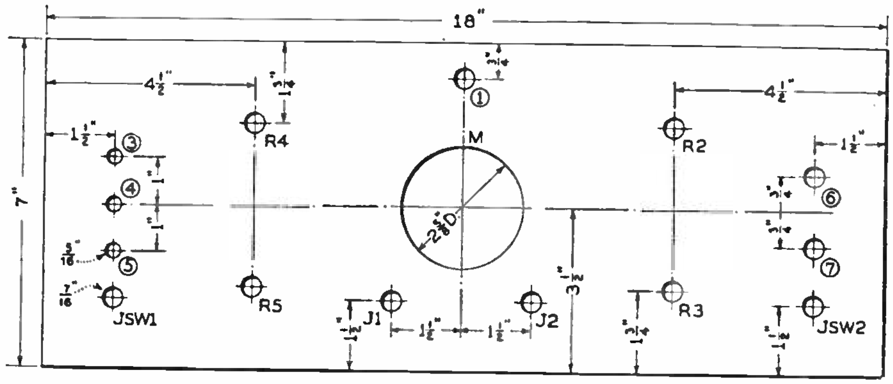
It may be well to start the description with a brief summary of the outstanding features embodied in this amplifier. In the first place, the entire unit is enclosed, but at the same time adequate ventilation is provided to dissipate the normal operating heat. Such enclosure is one of the few definite requirements of the Board of Underwriters. It prevents the operator from coming in contact with live parts; it protects the equipment itself from injury, and eliminates the fire hazard which may sometimes result from loose connections in high potential circuits.

All controls, switches, etc., are mounted on the outside front panel. Such as are not completely insulated are at ground potential so that there is no possibility of the operator receiving a shock. This is particularly true of the metallic switch knobs and the meter jacks. The former are insulated from current carrying circuits and the latter are at ground potential.

All parts employed in the entire unit are selected for their quality, and are such as to provide an ample factor of safety, thus guarding against a breakdown. The frame and the shelving are of metal construction, as is also the wire mesh which forms part of the housing. Grounding this metal work automatically grounds the cases of the individual instruments which are mounted thereon.

A line voltage control switch, Tap Switch No. 2, has been included to adapt the unit to the prevailing line voltage. No line voltmeter has been included in the set-up, but in localities where the line voltage fluctuates throughout the day, such a meter should be installed to permit the voltage regulator switch to be properly adjusted to meet these fluctuations.

The layout of the control panel on which are placed the change-over switches, grid bias resistors, plate jacks, etc.



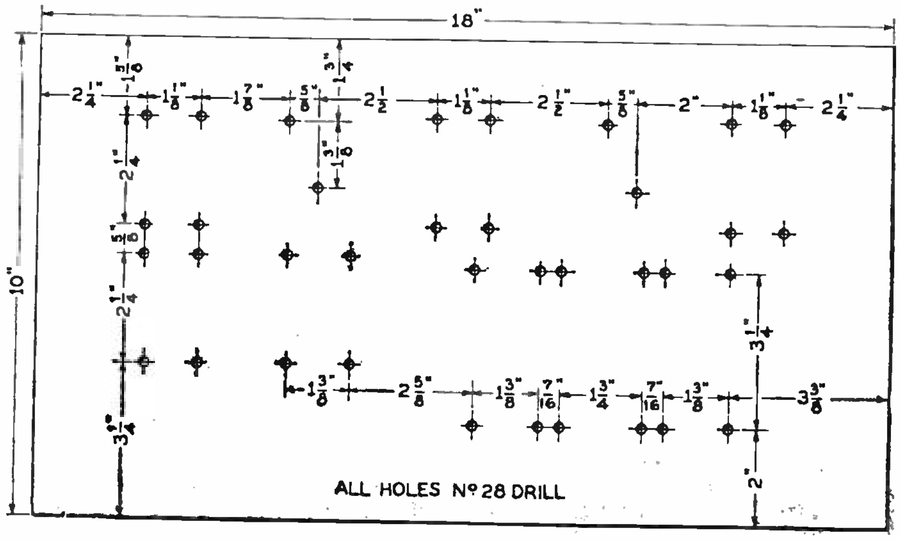
One unusual feature of this amplifier is found in the use of a bleeder resistance, which is automatically cut into the circuit when the radio receiver is turned off. This is required in cases where the amplifier is used with a phonograph part of the time. Inasmuch as the amplifier unit supplies plate voltages for a radio-frequency tuner, the plate voltages for the amplifier tubes would be increased when the tuner is turned off because of the decreased load. If the tuner employed contains only two or three tubes with low plate current consumption, the excess current would be little cause for worry. In many cases, however, the r. f. tubes may require 8 to 20 milliamperes. With the receiver turned off, this excess current would be sufficient to overload the amplifier tubes and eventually cause breakdowns.

The amplifier, as will be seen from a study of the schematic diagram, includes two stages with a single 350 power tube in the second stage. Normally, two audio stages are used ahead of a 350 power stage, but with the growing use of power detection, this is no longer considered necessary. With suitable input voltage from the receiver, this amplifier is capable of operating one or two dynamic speakers and up to thirty magnetic cone speakers, depending on the volume required from each speaker.

Input transformers T1 and T4, are provided for both radio and phonograph inputs respectively, with a switch JSW1 on the panel to permit instantaneous selection of either. Another switch JSW2 on the amplifier panel turns the receiver off when it is desired to use the phonograph. This latter switch also cuts in the bleeder resistance R5, referred to above.

A phonograph volume control, R4, is mounted on the amplifier panel, as is also a milliammeter with cord and plug. Two jacks are provided for plugging in the milliammeter. One of these, J2, provides a plate current reading for the 350 tube; the other gives a reading of all other plate currents combined. These two jacks, with the milliammeter, provide a definite check on the plate circuits of all tubes.

The template for drilling the upper shelf. The steel panel, of which this shelf is made, eliminates magnetic coupling between the audio and power units



One Power Section

The power supply unit incorporated in the amplifier supplies all of the A, B & C voltages for the amplifier, and also the plate voltages for the radio receiver. It is intended that the filaments of the receiver be operated from a storage battery which is connected through the re-

(Continued on page 378)

A COMPACT RECEIVER *for*

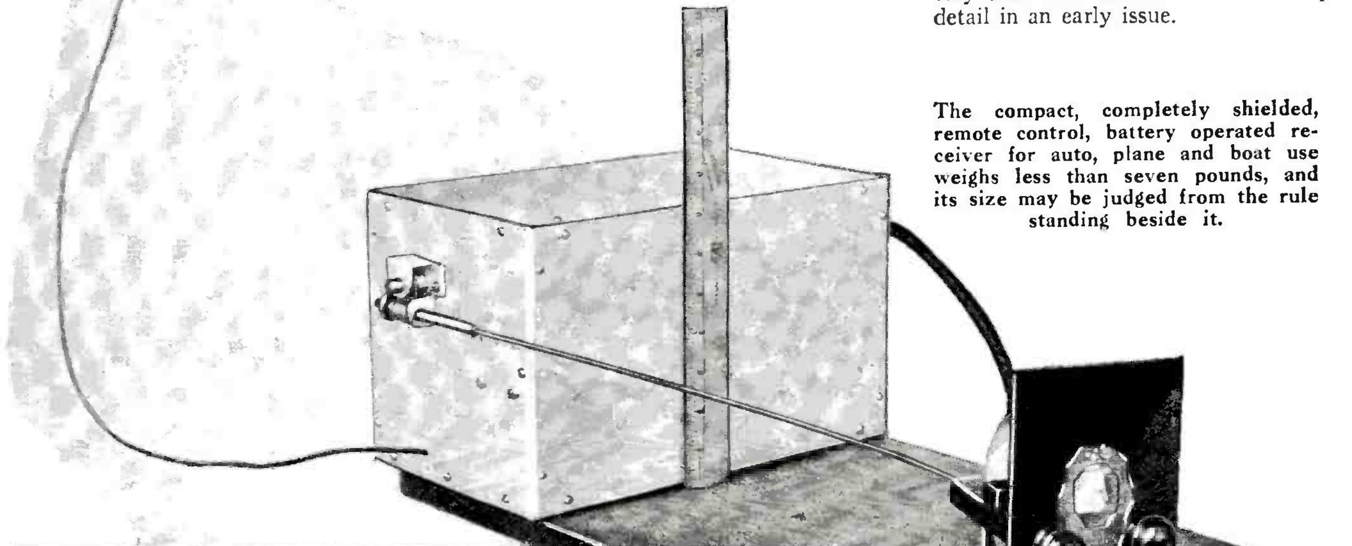
Auto, Plane or Motorboat

Entire Broadcast Range Can Be Covered by This Single-Dial Receiver Equipped With Remote Control

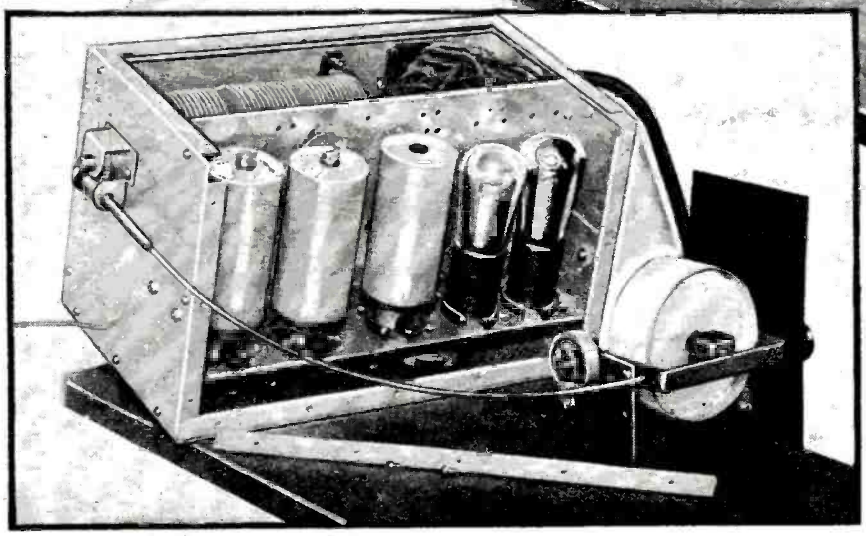
FROM the photographs it will be seen that the receiver illustrated here is extremely compact. The antenna required is very short. The entire antenna length is illustrated in the top view, and as may be observed by comparing it with the foot-rule standing beside the receiver, has a total length of approximately three feet. The entire case is made of angle aluminum and sheet aluminum, which makes the unit very rugged. The single driving shaft for the condenser assembly terminates in a gear which meshes with a worm drive attached to one end of the flexible remote control driving unit. The other end of this unit is attached to the dial by another gear arrangement. The compactness of the receiver makes it possible to install it under the dash in an automobile, in some convenient part of the fuselage in an aeroplane, or in any remote compartment in a motorboat away from a source of interference.

The volume control and tuning control may be carried to the dash or any other convenient place. The receiver itself is made with a.c. tubes operated from a d.c. or storage battery source, in order to reduce the possible pick-up of ignition noise from the high tension spark-plug lines. Two screen-grid tubes are used in the r.f. circuit, a 112A tube is used for the detector; this feeds into a three-stage resistance-coupled audio amplifier, which provides good tone quality. The use of resistance coupling makes the entire design of light weight.

The model shown here was designed by George A. Eckweiler and A. Gillette Clark. Another receiver, of somewhat similar nature, developed by RADIO NEWS Laboratory staff will be described in complete detail in an early issue.



The compact, completely shielded, remote control, battery operated receiver for auto, plane and boat use weighs less than seven pounds, and its size may be judged from the rule standing beside it.



With two of the outside surfaces of the combination shield and container removed the position of most of the units may well be visualized. From this layout other designs will suggest themselves to the experienced radio constructor.

List of Broadcast Stations in the United States and Canada

(Alphabetically, by Call Letters)

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
KCRC	Enid, Okla.	219	100
KDB	Santa Barbara, Calif.	200	100
KDKA	East Pittsburgh, Pa.	306	50000
KDLR	Devils Lake, N. D.	248	100
KDYL	Salt Lake City, Utah	232	1000
KEJK	Los Angeles, Calif. (Ltd.)	256	500
KELW	Burbank, Calif.	384	500
KEX	Portland, Oregon	254	5000
KFAB	Lincoln, Nebraska	389	5000
KFAD	Phoenix, Arizona	484	500
KFBB	Harve, Montana	220	500
KFBK	Sacramento, Calif.	229	100
KFBL	Everett, Washington	219	50
KFDM	Beaumont, Texas	535	500
KFDY	Brookings, S. D. (day)	545	1000
KFEL	Denver, Colorado	319	250
KFEQ	St. Joseph, Mo. (day)	535	2500
KFGQ	Boone, Iowa	229	100
KFH	Wichita, Kansas	231	500
KFHA	Gunnison, Colorado	250	50
KFI	Los Angeles, Calif.	468	5000
KFIF	Portland, Oregon	211	500
KFIO	Spokane, Wash. (day)	244	100
KFIZ	Fond du Lac, Wis.	211	100
KFJB	Marshalltown, Iowa	250	100
KFJF	Oklahoma City, Okla.	204	5000
KFJI	Astoria, Oregon	219	100
KFJM	Grand Forks, N. D.	219	100
KFJR	Portland, Oregon	231	500
KFJY	Fort Dodge, Iowa	229	100
KFJZ	Fort Worth, Texas	219	100
KFKA	Greeley, Colorado (day)	341	1000
KFKB	Milford, Kansas (day)	286	5000
KFKU	Lawrence, Kansas	246	1000
KFKX	Chicago, Illinois	294	5000
KFKZ	Kirksville, Missouri	250	15
KFLV	Rockford, Illinois	213	500
KFLX	Galveston, Texas	219	100
KFMX	Northfield, Minn.	240	1000
KFNF	Shenandoah, Iowa (day)	337	1000
KFOR	Lincoln, Nebraska	248	100
KFOX	Long Beach, Calif.	240	1000
KFPL	Dublin, Texas	229	15
KFPM	Greenville, Texas	229	15
KFPW	Siloam Springs, Ark. (day)	224	50
KFPY	Spokane, Wash.	224	500
KFQA	St. Louis, Mo	275	5000
KFQD	Anchorage, Alaska	244	100
KFQU	Holy City, Calif.	211	100
KFQW	Seattle, Wash	211	100
KFQZ	Hollywood, Cal. (Ltd.)	349	250
KFRC	San Francisco, Calif.	492	1000
KFRU	Columbia, Missouri	476	500
KFSD	San Diego, Calif. (day)	500	1000
KFSG	Los Angeles, Calif.	268	500
KFUL	Galveston, Texas	232	1000
KFUM	Colorado Springs, Colo	236	1000
KFUO	Clayton, Mo	545	500
KFUP	Denver, Colorado	229	100
KFVD	Culver City, Calif. (Ltd.)	422	250
KFVS	Cape Girardeau, Mo.	248	100
KFWB	Hollywood, Calif	316	1000
KFWC	Ontario, Calif	250	100
KFWF	St. Louis, Missouri	250	100
KFWI	San Francisco, Calif.	322	500
KFWM	Oakland, Calif.	322	500
KFXD	Jerome, Idaho	211	50
KFXF	Denver, Colorado	319	250
KFXJ	Edgewater, Colo.	229	50
KFXR	Oklahoma City, Okla.	229	100
KFXY	Flagstaff, Arizona	211	100
KFYO	Abilene, Texas	211	100
KFYR	Bismarck, N. D.	545	500
KGA	Spokane, Wash.	204	5000
KGAR	Tucson, Arizona	219	100
KGB	San Diego, Calif.	220	250
KGBU	Ketchikan, Alaska	333	500
KGBX	St. Joseph, Mo.	219	100
KGBZ	York, Nebraska	322	500
KGCA	Decorah, Iowa (day)	236	50
KGCI	San Antonio Texas	219	100
KGCR	Watertown, S. D.	248	100
KGCU	Mandan, N. D.	250	100
KGCX	Vida, Montana	211	10
KGDA	Dell Rapids, S. D.	219	50
KGDE	Fergus Falls, Minn.	250	50
KGDM	Stockton, Calif. (day)	273	50
KGDR	San Antonio, Texas	200	100
KGDY	Oldham, S. D.	250	15
KGEF	Los Angeles, Calif.	231	1000
KGEK	Yuma, Colo.	250	50
KGER	Long Beach, Calif.	219	100
KGEW	Fort Morgan, Colo	250	100
KGEZ	Kalispell, Montana	229	100
KGFF	Alva, Oklahoma	211	100
KGFG	Oklahoma City, Okla.	219	100
KGFI	San Angelo, Texas	200	100
KGFJ	Los Angeles, Calif.	211	100
KGFK	Hallock, Minnesota	250	50
KGFL	Raton, New Mexico	219	50
KGFW	Ravenna, Nebraska	211	50
KGFX	Pierre, S. D. (day)	517	200
KGGC	San Francisco, Calif.	211	50
KGGF	Picher, Oklahoma	297	500
KGGM	Albuquerque, N. M.	219	100
KGHF	Pueblo, Colorado	227	250
KGHG	McGehee, Ark.	229	50
KGHI	Little Rock, Ark.	200	100
KGHL	Billings, Montana	316	500
KGHX	Richmond, Texas	200	50
KGIQ	Twin Falls, Idaho	227	250
KGIR	Butte, Montana	220	250
KGIW	Trinidad, Colo.	211	100
KGIX	Las Vegas, Nevada	211	100
KGJF	Little Rock, Ark.	337	250
KGKB	Brownwood, Texas	200	100
KGKL	San Angelo, Texas	219	100
KGKO	Wichita Falls, Texas	526	250
KGKX	Sandpoint, Idaho	211	15
KGO	Oakland, Calif.	380	7500
KGRC	San Antonio, Texas	219	100
KGRS	Amarillo, Texas	213	1000
KGU	Honolulu, Hawaii	319	500
KGW	Portland, Oregon	484	1000
KGY	Lacey, Washington (day)	250	50
KHJ	Los Angeles, Calif.	333	1000
KHQ	Spokane, Wash.	508	1000
KICK	Red Oak, Iowa	211	100
KID	Idaho Falls, Idaho	227	250
KIDO	Boise, Idaho	240	1000
KIT	Yakima, Washington	219	50
KJBS	San Francisco, Cal. (day)	280	100
KJR	Seattle, Wash.	309	5000
KLCN	Blytheville, Ark. (day)	232	200
KLO	Ogden, Utah	219	100
KLRA	Little Rock, Ark.	216	1000
KLS	Oakland, Calif. (day)	208	250
KLX	Oakland, Calif.	341	500
KLZ	Dupont, Colo.	535	1000
KMA	Shenandoah, Iowa (day)	322	1000
KMBC	Independence, Mo. (day)	316	2500

THIS list of stations in the United States operating under licenses issued by the Federal Radio Commission is corrected to April 30, 1929. Powers shown are the night strength, or minimum.

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
KMED	Medford, Oregon	229	50
KMIC	Inglewood, Calif.	208	500
KMJ	Fresno, Calif.	250	100
KMMJ	Clay Center, Neb. (Ltd.)	405	1000
KMO	Tacoma, Wash.	224	500
KMOX	St. Louis, Mo.	275	5000
KMTR	Hollywood, Calif.	526	500
KNX	Los Angeles, Calif.	286	5000
KOA	Denver, Colo.	361	12500
KOAC	Corvallis, Oregon	535	1000
KOB	State College, New Mexico	254	10000
KOCW	Chickasha, Okla., (day)	214	500
KOH	Reno, Nevada	219	100
KOIL	Council Bluffs, Iowa, (day)	258	2500
KOIN	Portland, Oregon	319	1000
KOL	Seattle, Wash.	236	1000
KOMO	Seattle, Wash.	326	1000
KOOS	Marshfield, Oregon	219	50
KORE	Eugene, Oregon	211	100
KOY	Phoenix, Arizona	216	500
KPCB	Seattle, Wash.	248	100
KPJM	Prescott, Arizona	200	100
KPLA	Los Angeles, Calif.	500	1000
KPO	San Francisco, Cal	441	5000
KPOF	Denver, Colo.	341	500
KPPC	Pasadena, Calif.	250	50
KPQ	Seattle, Wash.	248	100
KPRC	Houston, Texas	326	1000
KPSN	Pasadena, Calif	316	1000
KPWF	Westminster, Cal.	214	10000
KQV	Pittsburgh, Pa.	217	500
KQW	San Jose, Calif.	297	500
KRE	Berkeley, Calif.	219	100
KRGV	Harlingen, Texas	238	500
KRLD	Dallas, Texas	288	10000
KRMD	Shreveport, La.	229	50
KRSC	Seattle, Wash. (day)	268	50
KSAC	Manhattan, Kans. (day)	517	1000
KSCJ	Sioux City, Iowa	225	1000
KSD	St. Louis, Mo.	545	500
KSEI	Pocatello, Idaho	333	250
KSL	Salt Lake City, Utah	265	5000
KSMR	Santa Maria, Calif.	250	100
KSO	Clarinda, Iowa	217	1000
KSOO	Sioux Falls, S. D. (day)	270	2000
KSTP	St. Paul, Minn.	205	10000
KTAB	Oakland, Calif.	545	500
KTAP	San Antonio, Texas	211	100
KTAT	Fort Worth, Texas	242	1000
KTBI	Los Angeles, Calif.	231	750
KTBR	Portland, Oregon	[illegible]	500
KTBS	Shreveport, La	297	500
KTHS	Hot Springs, Ark.	288	1000
KTM	Santa Monica, Calif.	428	500
KTNT	Muscatine, Iowa (day)	256	5000
KTSA	San Antonio, Texas (day)	232	2000
KTSL	Shreveport, La	229	100
KTUE	Houston, Texas	211	5
KTW	Seattle, Wash.	236	1000
KUJ	Seattle, Wash.	200	10
KUOA	Fayetteville, Ark.	216	1000
KUOM	Missoula, Mont.	526	500
KUSD	Vermillion, S. D. (day)	337	750
KUT	Austin, Texas	268	500
KVI	Des Moines, Wash.	394	1000
KVL	Seattle, Wash.	219	100
KVOA	Tucson, Ariz., (day)	211	500
KVOO	Tulsa, Okla.	263	5000
KVOS	Bellingham, Wash.	250	100
KWBS	Portland, Oregon	200	15
KWCR	Cedar Rapids, Iowa	229	100
KWEA	Shreveport, La.	248	100
KWJJ	Portland, Ore. (Ltd.)	283	500
KWK	St. Louis, Mo.	222	1000
KWKC	Kansas City, Mo.	219	100
KWKH	Kennonwood, La.	353	20000
KWLC	Decorah, Iowa (day)	236	100
KWSC	Pullman, Wash.	216	500
KWTC	Santa Ana, Calif.	200	100
KWWG	Brownsville, Texas	238	500
KWYO	Laramie, Wyoming	500	500
KXA	Seattle, Wash.	526	500
KXL	Portland, Oregon	240	500
KXO	El Centro, Calif.	250	100
KXRO	Aberdeen, Wash.	211	75
KYA	San Francisco, Calif.	244	1000
KYW	See KFKX		
KYWA	Chicago, Ill	294	500
KZM	Oakland, Calif.	219	100
NAA	Arlington, Va.	434	1000
WAAF	Chicago, Ill. (day)	326	500
WAAM	Newark, N. J. (day)	240	2000
WAAT	Jersey City, N. J. (day)	280	300
WAAW	Omaha, Neb. (day)	454	500
WABC	New York City	349	5000
WABI	Bangor, Me.	250	100
WABO	Rochester, N. Y.	208	500
WABZ	New Orleans, La.	250	100
WADC	Akron, Ohio	227	1000
WAFD	Detroit, Mich.	200	100
WAGM	Royal Oak, Mich.	229	50
WAIU	Columbus, Ohio (Ltd.)	468	500
WAPI	Birmingham, Ala.	263	5000
WASH	Grand Rapids, Mich.	236	250
WBAK	Harrisburg, Pa. (day)	210	500
WBAL	Baltimore, Md.	283	10000
WBAP	Fort Worth, Texas (LP)	375	50000
WBAW	Nashville, Tenn.	201	5000
WBAX	Wilkes-Barre, Pa.	248	100
WBBC	Brooklyn, N. Y. City	214	500
WBBL	Richmond, Va.	219	100
WBBM	Chicago, Ill.	389	10000
WBBR	Rossville, N. Y. City	231	1000
WBBY	Charleston, S. C.	250	75
WBBZ	Ponca City, Okla.	250	100
WBCM	Bay City, Mich.	213	500
WBCN	See WENR		
WBIS	Quincy, Mass.	244	1000
WBMS	Fort Lee, N. J.	207	200
WBNY	New York City	222	250
WBOQ	See WABC		
WBOW	Terre Haute, Ind.	229	100
WBRC	Birmingham, Ala. (day)	322	1000
WBRE	Wilkes-Barre, Pa.	229	100
WBRL	Tilton, N. H.	210	500
WBSO	Wellesley Hills, Mass. (day)	384	250
WBT	Charlotte, N. C.	278	5000
WBZ	Springfield, Mass.	303	15000
WBZA	Boston, Mass.	303	500
WCAC	Storrs, Conn.	500	250
WCAD	Canton, N. Y. (day)	246	500
WCAE	Pittsburgh, Pa.	246	500
WCAH	Columbus, Ohio	210	500
WCAJ	Lincoln, Neb.	508	500
WCAL	Northfield, Minn.	240	1000
WCAM	Camden, N. J.	234	500
WCAO	Baltimore, Md.	500	250
WCAP	Asbury Park, N. J.	234	500
WCAT	Rapid City, S. D.	250	100
WCAU	Philadelphia, Pa.	256	10000
WCAZ	Carthage, Ill. (day)	280	50
WCBA	Allentown, Pa.	208	250
WCBD	Zion, Illinois (day)	278	5000
WCBM	Baltimore, Md.	219	100
WCBS	Springfield, Ill.	248	100
WCCO	Minneapolis, Minn.	370	15000
WCDA	New York City	222	250
WCFL	Chicago, Ill. (Ltd.)	309	1500
WCGU	Brooklyn, N. Y. City	214	500
WCKY	Villa Madonna, Ky	203	5000
WCLB	Long Beach, N.Y.	200	100
WCLO	Kenosha, Wis.	250	100
WCLS	Joliet, Ill.	229	100
WCMA	Culver, Ind.	214	500
WCOA	Pensacola, Fla.	268	500
WCOC	Columbus, Miss.	341	500
WCOD	Harrisburg, Pa.	250	100
WCOH	Greenville, N. Y.	248	100
WCRW	Chicago, Ill.	248	100
WCSH	Portland, Maine	319	500
WCSO	Springfield, Ohio	217	500
WDAE	Tampa, Fla.	484	1000
WDAF	Kansas City, Mo.	492	1000
WDAG	Amarillo, Texas	213	250
WDAH	El Paso, Texas	229	100
WDAY	Fargo, N. D.	234	1000
WDBJ	Roanoke, Va. (day)	322	500
WDBO	Orlando, Fla.	484	1000
WDEL	Wilmington, Del. (day)	268	350
WDGY	Minneapolis, Minn. (Ltd.)	254	1000
WDOD	Chattanooga, Tenn.	234	500
WDRC	New Haven, Conn.	225	500
WDSU	New Orleans, La.	236	1000
WDWF	Cranston, R. I.	248	100
WDZ	Tuscola, Illinois, (day)	280	100
WEAF	New York City (LP)	454	50000
WEAI	Ithaca, N. Y. (day)	236	1000
WEAN	Providence, R. I. (day)	545	500
WEAO	Columbus, Ohio	545	750
WEAR	Cleveland, Ohio	280	1000
WEBC	Superior, Wis.	234	1000
WEBE	Cambridge, Ohio	248	100
WEBQ	Harrisburg, Ill.	248	100
WEBR	Buffalo, N. Y., (day)	229	200

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
WEBW	Beloit, Wis. (day)	500	350
WEDC	Chicago, Ill.	248	100
WEDH	Erie, Pa.	211	30
WEEI	Boston, Mass.	508	500
WEHS	Evanston, Ill.	229	100
WELK	Philadelphia, Pa.	219	100
WEMC	Berrien Springs, Mich. (day)	508	1000
WENR	Chicago, Ill. (LP)	345	50000
WEPS	Gloucester, Mass.	250	100
WEVD	New York City	231	500
WEW	St. Louis, Mo. (day)	395	1000
WFAA	Dallas, Texas (CP).	375	500 50kw
WFAN	Philadelphia, Pa.	492	500
WFBC	Knoxville, Tenn.	250	50
WFBG	Altoona, Pa.	229	100
WFBJ	Collegeville, Minn.	219	100
WFBL	Syracuse, N. Y.	333	750
WFBM	Indianapolis, Ind. (Ltd.)	244	1000
WFBR	Baltimore, Md. (temp.)	236	250
WFDF	Flint, Michigan	229	100
WFI	Philadelphia, Pa.	535	500
WFIW	Hopkinsville, Ky.	319	1000
WFJC	Akron, Ohio	207	500
WFKD	Philadelphia, Pa.	229	50
WFLA	See WSUN		
WGAL	Lancaster, Pa.	229	15
WGBB	Freeport, N. Y.	248	100
WGBC	Memphis, Tenn.	210	500
WGBF	Evansville, Ind.	476	500
WGBI	Scranton, Pa.	341	250
WGBS	New York City (Limited)	254	500
WGCM	Gulfport, Miss.	248	100
WGCP	Newark, N. J.	240	250
WGES	Chicago, Ill.	220	500
WGH	Newport News, Va.	229	100
WGHP	Fraser, Mich	282	750
WGL	Fort Wayne, Ind.	219	100
WGMS	See WLB		
WGN	Chicago, Ill.	416	25000
WGR	Buffalo, N. Y.	545	1000
WGST	Atlanta, Ga. (day)	337	250
WGY	Schenectady, N. Y.	380	50000
WHA	Madison, Wis. (day)	319	750
WHAD	Milwaukee, Wis.	268	250
WHAM	Rochester, N. Y.	261	5000
WHAP	New York City	231	1000
WHAS	Louisville, Ky.	366	5000
WHAZ	Troy, N. Y.	231	500
WHBC	Canton, Ohio	250	10
WHBD	Bellefontaine, Ohio	219	100
WHBF	Rock Island, Ill.	248	100
WHBL	Sheboygan, Wis.	213	500
WHBP	Johnstown, Pa.	229	100
WHBQ	Memphis, Tenn.	219	100
WHBU	Anderson, Indiana	248	100
WHBY	West De Pere, Wis. (L. T.)	250	100
WHDF	Calumet, Mich.	219	100
WHDH	Gloucester, Mass. (day)	361	1000
WHDI	Minneapolis, Minn. (L. T.)	254	1500
WHDL	Tupper Lake, N. Y. (day)	211	10
WHEC	See WABO		
WHFC	Cicero, Ill	229	100
WHIS	Bluefield, W. Va.	211	100
WHK	Cleveland, Ohio	216	1000
WHN	New York City	297	250
WHO	Des Moines, Iowa	300	5000
WHP	Harrisburg, Pa.	210	500
WIAS	Ottumwa, Iowa	211	100
WIBA	Madison, Wis.	248	100
WIBG	Elkins Park, Pa. (day)	322	50
WIBM	Jackson, Mich.	219	100
WIBO	Chicago, Ill.	526	1000
WIBR	Steubenville, Ohio	211	50
WIBS	Elizabeth, N. J.	207	250
WIBU	Poynette, Wis.	229	100
WIBW	Topeka, Kans.	231	1000
WIBX	Utica, N. Y.	250	100
WICC	Bridgeport, Conn. (day)	252	500
WIL	St. Louis, Mo.	250	100
WILL	Urbana, Ill.	337	250
WILM	Wilmington, Del.	211	100
WINR	Bay Shore, N. Y.	248	100
WIOD	Miami Beach, Fla.	535	1000
WIP	Philadelphia, Pa.	492	500
WISN	Milwaukee, Wis.	268	250
WJAD	Waco, Texas	242	1000
WJAG	Norfolk, Neb. (day)	283	1000
WJAK	Marion, Ind.	229	50
WJAR	Providence, R. I.	337	250
WJAS	Pittsburgh, Pa.	232	1000
WJAX	Jacksonville, Fla.	238	1000
WJAY	Cleveland, Ohio (day)	484	500
WJAZ	Chicago, Ill.	203	5000
WJBC	LaSalle, Ill.	250	100
WJBI	Red Bank, N. J.	248	100
WJBK	Ypsilanti, Mich.	219	50
WJBL	Decatur, Ill.	250	100
WJBO	New Orleans, La.	219	100
WJBT	See WBBM		
WJBU	Lewisburg, Pa.	248	100
WJBW	New Orleans, La.	250	30
WJBY	Gadsden, Ala.	248	50
WJJD	Mooseheart, Ill. (Ltd.)	265	20000
WJKS	Gary, Ind.	220	500
WJR	Pontiac, Mich.	400	5000
WJSV	Mt. Vernon Hills, Va.	205	10000
WJW	Mansfield, Ohio.	248	100
WJZ	New York City (L. P.)	395	30000
WKAQ	San Juan, Porto Rico	337	500
WKAR	East Lansing, Mich. (day)	288	1000
WKAV	Laconia, N. H.	229	100
WKBB	Joliet, Ill.	229	100
WKBC	Birmingham, Ala.	229	100
WKBE	Webster, Mass.	250	100
WKBF	Indianapolis, Ind.	214	500
WKBH	La Crosse, Wis.	217	1000
WKBI	Chicago, Ill.	229	50
WKBN	Youngstown, Ohio	526	500
WKBO	Jersey City, N. J.	207	250
WKBP	Battle Creek, Mich.	211	50
WKBQ	New York City	222	250
WKBS	Galesburg, Ill.	229	100
WKBV	Brookville, Ind.	200	100
WKBW	Buffalo, N. Y.	204	5000
WKBZ	Ludington, Mich.	200	50
WKEN	Buffalo, N. Y. (Ltd.)	288	1000
WKJC	Lancaster, Pa.	250	100
WKRC	Cincinnati, Ohio	545	500
WKY	Oklahoma City, Okla.	333	1000
WLAC	Nashville, Tenn.	201	5000
WLAP	Louisville, Ky.	250	30
WLB	Minneapolis, Minn.	240	500
WLBC	Muncie, Ind.	229	50
WLBF	Kansas City, Mo.	211	100
WLBG	Ettrick, Va.	250	100
WLBL	Stevens Point, Wis. (day)	333	2000
WLBW	Oil City, Pa.	238	500
WLBX	Long Island City, N. Y.	200	100
WLBZ	Bangor, Maine	484	250
WLCI	Ithaca, N. Y.	248	50
WLEX	Medford, Mass.	220	500
WLEY	Lexington, Mass.	211	100
WLIB	See WGN		
WLIT	Philadelphia, Pa.	535	500
WLOE	Chelsea, Mass.	200	100
WLS	Chicago, Ill.	345	5000
WLSI	See WDWF		
WLTH	Brooklyn, N. Y.	214	500
WLW	Cincinnati, Ohio (L.P.)	428	50000
WLWL	New York City	273	5000
WMAC	Cazenovia, N. Y.	526	250
WMAF	So. Dartmouth, Mass.	220	500
WMAK	Buffalo, N. Y.	333	750
WMAL	Washington, D. C.	476	250
WMAN	Columbus, Ohio	248	50
WMAQ	Chicago, Ill.	447	5000
WMAZ	Macon, Ga.	337	250
WMBA	Newport, R. I.	200	100
WMBC	Detroit, Mich.	211	100
WMBD	Peoria, Ill.	208	500
WMBG	Richmond, Va.	248	100
WMBH	Joplin, Mo.	211	100
WMBI	Chicago, Ill. (Ltd.)	278	5000
WMBJ	Wilkinsburg, Pa.	200	100
WMBL	Lakeland, Fla.	229	100
WMBO	Auburn, N. Y.	219	100
WMBQ	Brooklyn, N. Y.	200	100
WMBR	Tampa, Fla.	248	100
WMC	Memphis, Tenn.	526	500
WMCA	New York City	526	500
WMES	Boston, Mass.	200	50
WMMN	Fairmont, W. Va.	337	250
WMPC	Lapeer, Mich.	200	100
WMRJ	Jamaica, N. Y. City	211	10
WMSG	New York City	222	250
WMT	Waterloo, Iowa	250	100
WNAC	See WBIS		
WNAD	Norman, Okla.	297	500
WNAT	Philadelphia, Pa.	229	100
WNAX	Yankton, S. D.	526	1000
WNBF	Binghamton, N. Y.	200	50
WNBH	New Bedford, Mass.	229	100
WNBJ	Knoxville, Tenn.	229	50
WNBO	Washington, Pa.	250	100
WNBR	Memphis, Tenn.	210	500
WNBW	Carbondale, Pa.	250	5
WNBX	Springfield, Vt.	250	10
WNBZ	Saranac Lake, N. Y. (day)	232	50
WNJ	Newark, N. J.	207	250
WNOX	Knoxville, Tenn.	535	1000
WNRC	Greensboro, N. C.	208	250
WNYC	New York City	526	500
WOAI	San Antonio, Texas	252	5000
WOAN	Lawrenceburg, Tenn.	500	500
WOAX	Trenton, N. J.	234	500
WOBT	Union City, Tenn.	229	15
WOBU	Charleston, W. Va.	517	250
WOC	Davenport, Iowa	300	5000
WOCL	Jamestown, N. Y.	248	25
WODA	Paterson, N. J.	240	1000
WOI	Ames, Iowa (day)	535	3500
WOKO	Mt. Beacon, N.Y.	208	500
WOL	Washington, D.C.	229	100
WOMT	Manitowoc, Wis.	248	100
WOOD	Grand Rapids, Mich.	236	500
WOPI	Bristol, Tenn	200	100
WOQ	Kansas City, Mo.	492	1000
WOR	Newark, N. J.	422	5000
WORD	Chicago, Ill.	203	5000
WOS	Jefferson City, Mo.	476	500
WOV	New York City (day)	265	1000
WOW	Omaha, Neb.	508	1000
WOWO	Fort Wayne, Ind.	258	1000
WPAP	New York City	297	250
WPAW	Pawtucket, R. I.	248	100
WPCC	Chicago, Ill.	526	500
WPCH	New York City (day)	370	500
WPG	Atlantic City, N. J.	273	5000
WPOE	Patchogue, N. Y.	211	30
WPOR	See WTAR		
WPSC	State College, Pa. (day)	244	500
WPSW	Philadelphia, Pa.	200	50
WPTF	Raleigh, N. C.	441	1000
WQAM	Miami, Fla.	242	1000
WQAO	See WPAP		
WQBC	Utica, Miss.	220	300
WQBZ	Weirton, W. Va.	211	60
WRAF	LaPorte, Ind.	250	100
WRAK	Erie, Pa.	219	50
WRAW	Reading, Pa.	229	100
WRAX	Philadelphia, Pa. (day)	246	250
WRBC	Valparaiso, Ind. (day)	242	500
WRBI	Tifton, Ga.	229	20
WRBJ	Hattiesburg, Miss.	200	10
WRBL	Columbus, Ga.	250	50
WRBQ	Greenville, Miss.	248	100
WRBT	Wilmington, N. C.	219	100
WRBU	Gastonia, N. C.	248	100
WRC	Washington, D. C.	316	500
WREC	Memphis, Tenn.	500	500
WREN	Lawrence, Kansas	246	1000
WRHM	Minneapolis, Minn.	240	1000
WRJN	Racine, Wis.	219	100
WRK	Hamilton, Ohio	229	100
WRNY	New York City	297	250
WRR	Dallas, Texas	234	500
WRUF	Gainesville, Fla.	204	5000
WRVA	Richmond, Va.	270	1000
WSAI	Cincinnati, Ohio (Ltd.)	226	500
WSAJ	Grove City, Pa.	229	100
WSAN	Allentown, Pa.	208	250
WSAR	Portsmouth, R. I.	207	250
WSAZ	Huntington, W. Va.	517	250
WSB	Atlanta, Ga.	405	1000
WSBT	South Bend, Ind.	244	500
WSDA	Brooklyn, N. Y.	214	500
WSGH	See WSDA		
WSIX	Springfield, Tenn.	248	100
WSM	Nashville, Tenn.	461	5000
WSMB	New Orleans, La.	227	500
WSMK	Dayton, Ohio	526	200
WSOA	Deerfield, Ill	203	5000
WSPD	Toledo, Ohio	224	500
WSSH	Boston, Mass.	211	100
WSUI	Iowa City, Iowa	517	500
WSUN	St. Petersburg, Fla.	333	1000
WSVS	Buffalo, N. Y.	219	50
WSYR	Syracuse, N. Y.	526	250
WTAD	Quincy, Ill.	208	500
WTAG	Worcester, Mass.	517	250
WTAM	Cleveland, Ohio	280	3500
WTAQ	Washington, Wis.	225	1000
WTAR	Norfolk, Va.	384	500
WTAW	College Station, Texas	268	500
WTAX	Streator, Ill.	248	50
WTBO	Cumberland, Md.	211	50
WTFI	Toccoa Falls, Ga.	207	250
WTIC	Hartford, Conn.	500	250
WTMJ	Milwaukee, Wis.	484	1000
WWAE	Hammond, Ind	250	100
WWJ	Detroit, Mich.	326	1000
WWL	New Orleans, La.	353	5000
WWNC	Asheville, N. C.	526	1000
WWRL	Woodside, N. Y.	200	100
WWVA	Wheeling, W. Va.	258	250

LIST OF CANADIAN BROADCAST CALLS

CFAC	Calgary, Alta.	434	500
CFBO	St. Johns, N. B.	337	50
CFCA	Toronto, Ont.	357	500
CFCF	Montreal, Que.	291	1650
CFCH	Iroquois Falls, Ont.	500	250
CFCL	See CKLC		
CFCN	Calgary, Alta.	434	1800
CFCO	Chatham, Ont.	248	25
CFCT	Victoria, B. C.	476	500
CFCY	Charlottetown, P. E. I.	312	100
CFJC	Kamloops, B. C.	268	15
CFLC	Prescott, Ontario	297	50
CFNB	Fredericton, N. B.	248	50
CFQC	Saskatoon, Sask.	329	500
CFRB	Toronto, Ont.	312	1000
CFRC	Kingston, Ont.	268	500
CHCA	See CJCJ		
CHCK	Charlottetown, P. E. I.	312	30
CHCS	Hamilton, Ont.	341	10
CHCT	See CKCL		
CHGS	Summerside, P. E. I.	268	25
CHLS	See CKCD		
CHMA	Edmonton, Alta.	517	250
CHML	Mount Hamilton, Ont.	341	50
CHNC	See CKNC		
CHNS	Halifax, N. S.	322	500
CHRC	Quebec, Quebec	500	25
CHWC	Regina, Sask.	312	500
CHWK	Chilliwack, B. C.	248	5
CHYC	Montreal, Que.	411	750
CJBC	(Uses several Toronto stations)	517, 357 or 312	
CJBR	See CKCK		
CJCA	Edmonton, Alta.	517	500
CJCB	Sydney, Nova Scotia	384	50
CJCJ	Calgary, Alta.	434	250
CJGC	London, Ont.	329	500
CJGX	Yorkton, Sask.	476	500
CJHS	Saskatoon, Sask.	329	250
CJOC	Lethbridge, Alta.	268	50
CJOR	Sea Island, B. C.	291	50
CJRM	Moose Jaw, Sask.	500	500
CJRW	Fleming, Sask.	500	500
CJSC	See CKCL		
CKAC	Montreal, Que.	411	1200
CKCD	Vancouver, B. C.	411	50
CKCI	Quebec, Que.	500	23
CKCK	Regina, Sask.	312	500
CKCL	Toronto, Ont.	517	500
CKCO	Ottawa, Ont.	434	100
CKCR	Brantford, Ont.	297	50
CKCV	Quebec, Que.	500	50
CKFC	Vancouver, B. C.	411	50
CKGW	Bowmanville, Ont.	312	5000
CKLC	Red Deer, Alberta	357	1000
CKMC	Cobalt, Ont.	248	15
CKMO	Vancouver, B. C.	411	50
CKNC	Toronto, Ont.	517	500
CKOC	Hamilton, Ont.	341	100
CKOW	See CFCA		
CKPC	Preston, Ont.	248	25
CKPR	Midland, Ont.	268	50
CKSH	St. Hyacinthe, Que.	297	50
CKUA	Edmonton, Alta.	517	500
CKWX	Vancouver, B. C.	411	100
CKX	Brandon, Man.	556	500
CKY	Winnipeg, Man.	384	5000
CNRA	Moncton, N. B.	476	500
CNRC	See CFAC		
CNRE	See CJCA		
CNRM	See CHYC, CKAC, or CFCF		
CNRO	Ottawa, Ont.	434	500
CNRQ	See CKCV		
CNRR	See CKCK		
CNRS	See CFQC		
CNRT	See CFCA		
CNRV	Vancouver, B. C.	291	500
CNRW	See CKY		
VAS	Louisburg, Nova Scotia	434	

Wave (Meters)	Radio Call Letters	BROADCAST STA. Location	Power (Watts)
545,1	KFDY	Brookings, S. D.	500
	KFUO	Clayton, Mo.	500
	KFYR	Bismarck, N. D.	500
	KSD	St. Louis, Mo.	500
	KTAB	Oakland, Calif.	500
	WEAN	Providence, R. I.	250
	WEAO	Columbus, Ohio	750
	WGR	Buffalo, N. Y.	1000
	WKRC	Cincinnati, Ohio	500
535,4	KFDM	Beaumont, Texas	500
	KFEQ	St. Joseph, Mo. (day)	2500
	KLZ	Dupont, Colo.	1000
	KOAC	Corvallis, Oregon	1000
	WFI	Philadelphia, Pa.	500
	WIOD	Miama, Fla.	1000
	WLIT	Philadelphia, Pa.	500
	WNOX	Knoxville, Tenn.	1000
	WOI	Ames, Iowa (day)	3500
526,	KGKO	Wichita Falls, Texas	250
	KMTR	Hollywood, Calif.	500
	KUOM	Missoula, Montana	500
	KXA	Seattle, Wash.	500
	WIBO	Chicago, Ill.	1000
	WKBN	Youngstown, Ohio	500
	WMAC	Cazenovia, N. Y.	250
	WMC	Memphis, Tenn.	500
	WMCA	New York, N. Y.	500
	WNAX	Yankton, S. D.	1000
	WNYC	New York, N. Y.	500
	WPCC	Chicago, Ill.	500
	WSMK	Dayton, Ohio	200
	WSYR	Syracuse, N. Y.	250
	WWNC	Asheville, N. C.	1000
516,9	KGFX	Pierre, S. D. (day)	200
	KSAC	Manhattan, Kansas	500
	WOBU	Charleston, W. Va.	250
	WSAZ	Huntington, W. Va.	250
	WSUI	Iowa City, Iowa	500
	WTAG	Worcester, Mass.	250
508,2	KHQ	Spokane, Wash.	1000
	WCAJ	Lincoln, Neb.	500
	WEEI	Boston, Mass.	500
	WEMC	Berrien Springs, Mich.	1000
	WOW	Omaha, Neb.	1000
499,7	KFSD	San Diego, Cal.	500
	KWYO	Laramie, Wyo.	500
	WCAC	Storrs, Conn.	250
	WCAO	Baltimore, Md.	250
	WEBW	Beloit, Wis.	350
	WOAN	Lawrenceburg, Tenn.	500
	WREC	Memphis, Tenn.	500
491,5	KFRC	San Francisco, Calif.	1000
	WDAF	Kansas City, Mo.	1000
	WFAN	Philadelphia, Pa.	500
	WIP	Philadelphia, Pa.	500
	WOQ	Kansas City, Mo.	1000
483,6	KFAD	Phoenix, Ariz.	500
	KGW	Portland, Oregon	1000
	WDAE	Tampa, Fla.	1000
	WDBO	Orlando, Fla.	1000
	WLBZ	Bangor, Me.	250
	WTMJ	Milwaukee, Wis.	1000
475,9	KFRU	Columbia, Mo.	500
	WGBF	Evansville, Ind.	500
	WMAL	Washington, D. C.	250
	WOS	Jefferson City, Mo.	500
468,5	KFI	Los Angeles, Calif.	5000
	WAIU	Columbus, Ohio	500
461,3	WSM	Nashville, Tenn.	5000
454,3	WAAW	Omaha, Neb.	500
	WEAF	New York, N. Y.	50000
447,5	WMAQ	Chicago, Ill.	5000
440,9	KPO	San Francisco, Calif.	5000
	WPTF	Raleigh, N. C.	1000
434,5	NAA	Arlington, Va.	1000
	KFVD	Venice, Calif.	250
	WLW	Cincinnati, Ohio	50000
	KTM	Santa Monica, Cal.	500
422,3	WOR	Newark, N. J.	5000
	KFVD	Culver City, Cal.	250
416,4	WGN	Chicago, Ill.	25000
	WLIB	Chicago, Ill.	25000
405,2	KMMJ	Clay Center ,Neb. (day)	1000
	WSB	Atlanta, Ga.	1000
	WJR	Pontiac, Mich.	5000
394,5	KVI	Des Moines, Wash.	1000
	WEW	St. Louis, Mo. (day)	1000
	WJZ	New York, N. Y.	30000
389,4	KFAB	Lincoln, Neb.	5000
	WBBM	Chicago, Ill.	10000
	WJBT	Chicago, Ill.	25000
384,4	KELW	Burbank, Calif.	500
	WBSO	Wellesley Hills, Mass.	250
	WPOR	Norfolk, Va.	500
	WTAR	Norfolk, Va.	500
379,5	KGO	Oakland, Calif.	7500
	WGY	Schenectady, N. Y.	50000
374,8	WBAP	Fort Worth, Texas	50000
	WFAA	Dallas, Texas	500
370,2	WCCO	Minn., St. Paul, Minn.	15000
	WPCH	New York, N. Y.	500
365,6	WHAS	Louisville, Ky.	5000
361,2	KOA	Denver, Colo.	13500
	WHOH	Gloucester, Mass.	500
352,7	KWKH	Kennonwood, La.	20000
	WWL	Gloucester, Mass.	5000
348,6	KFQZ	Hollywood, Calif.	250
	WABC	New York City, N. Y.	5000
	WBOQ	New York City, N. Y.	5000
344,6	WBCN	Chicago, Ill.	25000
	WENR	Chicago, Ill.	25000
	WLS	Chicago, Ill.	5000
340,7	KFKA	Greeley, Colo.	500
	KLX	Oakland, Calif.	500
	KPOF	Denver, Colo.	500
	WCOC	Columbus, Miss.	500
	WGBI	Scranton, Pa.	250
336,9	KFNF	Shenandoah, Iowa	500
	KGJF	Little Rock, Ark.	250
	KUSD	Vermillion, S. D.	500
	WGST	Atlanta, Ga.	250
	WILL	Urbana, Ill.	250
	WJAR	Providence, R. I.	250
	WMAZ	Macon, Ga.	250
	WMMN	Fairmont, W. Va.	250
333,1	KHJ	Los Angeles, Calif.	1000
	KSEI	Pocatello, Idaho	250
	WFBL	Syracuse, N. Y.	750
	WFLA	Clearwater, Fla.	1000
	WKY	Oklahoma City, Okla.	1000
	WLBL	Stevens Point, Wis. (day)	2000
	WMAK	Buffalo, N. Y.	750
	WSUN	Clearwater, Fla.	1000
325,9	KOMO	Seattle, Wash.	1000
	KPRC	Houston, Texas	1000
	WAAF	Chicago, Ill. (day)	500
	WWJ	Detroit, Mich.	1000

Wave (Meters)	Radio Call Letters	BROADCAST STA. Location	Power (Watts)
322,4	KFWI	San Francisco, Calif.	500
	KFWM	Oakland, Calif.	500
	KMA	Shenandoah, Iowa	500
	WBRC	Birmingham, Ala.	500
	WDBJ	Roanoke, Va.	250
	WIBG	Elkins Park, Pa. (Sunday)	50
319,	KFEL	Denver, Colo.	250
	KFXF	Denver, Colo.	250
	KOIN	Portland, Oregon	1000
	WCHS	Portland, Maine	500
	WFIW	Hopkinsville, Ky.	1000
	WHA	Madison, Wis.	750
315,6	KFWB	Hollywood, Calif.	1000
	KGHL	Billings, Mont.	500
	KMBC	Independence, Mo.	1000
	KPSN	Pasadena, Calif.	1000
	WRC	Washington, D. C.	500
309,1	KJR	Seattle, Wash.	5000
	WCFL	Chicago, Ill.	1500
305,9	KDKA	Pittsburgh, Pa.	50000
302,8	WBZ	Springfield, Mass.	15000
	WBZA	Boston, Mass.	500
299,8	KPLA	Los Angeles, Calif.	1000
	WHO	Des Moines, Iowa	5000
	WOC	Davenport, Iowa	5000
296,9	KGGF	Picher, Okla.	500
	KOW	San Jose, Calif.	500
	WHN	New York, N. Y.	500
	WNAD	Norman, Okla.	250
	WPAP	Palisade, N. J.	250
	WQAO	Cliffside, N. J.	250
	WRNY	New York, N. Y.	250

THIS list of stations in the United States operating under licenses issued by the Federal Radio Commission is corrected to April 30, 1929. Powers shown are the night strength, or minimum.

Wave (Meters)	Radio Call Letters	BROADCAST STA. Location	Power (Watts)
293,9	KFKX	Chicago, Ill.	5000
	KYW	Chicago, Ill.	5000
	KYWA	Chicago, Ill.	500
	WRAX	Philadelphia, Pa. (day)	250
288,3	KRLD	Dallas, Texas	10000
	KTHS	Hot Springs Nat'l Park, Ark.	1000
	WKAR	East Lansing, Mich. (day)	500
	WFAA	Dallas, Texas	500
	WKEN	Buffalo, N. Y.	1000
285,5	KNX	Los Angeles, Calif.	5000
282,8	KWJJ	Portland, Oregon	500
	WBAL	Baltimore, Md.	10000
	WJAG	Norfolk, Neb. (day)	500
	WTIC	Hartford, Conn.	50000
280,2	WAAT	Jersey City, N. J. (day)	300
	WCAZ	Carthage, Ill. (day)	50
	WDZ	Tuscola, Ill.	100
	WEAR	Cleveland, Ohio	1000
	WTAM	Cleveland, Ohio	3500
277,6	WBT	Charlotte, N. C.	5000
	WCBD	Zion, Ill. (day)	5000
	WMBI	Addison, Ill. (day)	5000
275,1	KFQA	St. Louis, Mo.	5000
	KMOX	St. Louis, Mo.	5000
272,6	KGBS	San Francisco, Calif. (day)	100
	WLWL	New York City, N. Y.	5000
	WPG	Atlantic City, N. J.	5000
270,1	KSOO	Sioux Falls, S. D. (day)	2000
	WRVA	Richmond, Va.	1000
267,7	KFSG	Los Angeles, Calif.	500
	KMIC	Inglewood, Calif.	500
	KRSC	Seattle, Wash. (day)	50
	KUT	Austin, Texas	500
	WCOA	Pensacola, Fla.	500
	WDEL	Wilmington, Del.	250
	WHAD	Milwaukee, Wis. (day)	250
	WISN	Milwaukee, Wis.	250
	WTAW	College Station, Texas	500
265,3	KFKB	Milford, Kansas (day)	5000
	KSL	Salt Lake City, Utah	5000
	WOV	New York, N. Y. (day)	1000
263	KVOO	Tulsa, Okla.	5000
	WAPI	Auburn, Ala.	5000
260.7	KGDM	Stockton, Calif. (day)	50
	WHAM	Rochester, N. Y.	5000
258.5	WOWO	Fort Wayne, Ind.	1000
	WWVA	Wheeling, W. Va.	250
256.3	KTNT	Muscatine, Iowa (day)	5000
	WCAU	Philadelphia, Pa.	10000
254.1	KEX	Portland, Oregon	5000
	KOB	State College, N. Mex.	10000
	WGBS	New York, N. Y.	500
	WHDI	Minneapolis, Minn.	1500
	WJJD	Mooseheart, Ill.	20000
252	WICC	Bridgeport, Conn. (day)	500
	WOAI	San Antonio, Texas	5000
	WRR	Dallas, Texas	5000
249.9	KFHA	Gunnison, Colo.	50
	KFJB	Marshalltown, Iowa	100
	KFKZ	Kirksville, Mo.	15
	KFWC	Ontario, Calif.	100
	KFWF	St. Louis, Mo.	100
	KGCU	Mandan, N. D.	100
	KGDE	Fergus Falls, Minn.	50
	KGDY	Oldham, S. D.	15
	KGEK	Yuma, Colo.	50
	KGEW	Fort Morgan, Colo.	100
	KGFK	Hallock, Minn.	50
	KGY	Lacey, Wash.	10
	KMJ	Fresno, Calif.	100
	KOX	El Centro, Calif.	15
	KPPC	Pasadena, Calif.	50
	KSMR	Santa Maria, Calif.	100
	KVOS	Bellingham, Wash.	100
	WABI	Bangor, Maine	100
	WABZ	New Orleans, La.	100
	WBBW	Norfolk, Va.	100
	WBBY	Charleston, S. C.	75
	WBBZ	Ponca City, Okla.	100
	WCAT	Rapid City, S. D.	100
	WCLO	Kenosha, Wis.	100
	WEPS	Gloucester, Mass.	100
	WFBC	Knoxville, Tenn.	50
	WHBC	Canton, Ohio	10
	WHBY	West De Pere, Wis.	50
	WIBX	Utica, N. Y.	100
	WIL	St. Louis, Mo.	100
	WJBC	La Salle, Ill.	100
	WJBL	Decatur, Ill.	100
	WJBW	New Orleans, La.	30
	WKBE	Webster, Mass.	100
	WKJC	Lancaster, Pa.	100
	WLAP	Louisville, Ky.	30

Wave (Meters)	Radio Call Letters	BROADCAST STA. Location	Power (Watts)
	WLBG	Ettrick, Va.	100
	WMAY	St. Louis, La.	100
	WMT	Cedar Rapids, Iowa	100
	WNBO	Washington, Pa.	100
	WNBW*	Carbondale, Pa.	5
	WNBX	Springfield, Vt.	10
	WCOD	Harrisburg, Pa.	100
	WQBJ	Clarksburg, W. Va.	65
	WRAF	Laporte, Ind.	100
	WRBL	Columbus, Ga.	50
	WRJN	Racine, Wis.	100
	WWAE	Hammond, Ind.	100
247.8	KDLR	Devils Lake, N. D.	100
	KFOR	Lincoln, Neb.	100
	KFVS	Cape Girardeau, Mo.	100
	KGCR	Brookings, S. D.	100
	KPCB	Seattle, Wash.	100
	KPQ	Seattle, Wash.	100
	KWEA	Shreveport, La.	100
	WBAX	Wilkes-Barre, Pa.	100
	WCBS	Springfield, Ill.	100
	WCOH	Greenville, N. Y.	100
	WCRW	Chicago, Ill.	100
	WDWF	Cranston, R. I.	100
	WEBE	Cambridge, Ohio	100
	WEBQ	Harrisburg, Ill.	100
	WEDC	Chicago, Ill.	100
	WGBB	Freeport, N. Y.	100
	WGCM	Gulfport, Miss.	100
	WHBF	Rock Island, Ill.	100
	WHBU	Anderson, Ind.	100
	WIBA	Madison, Wis.	100
	WINR	Bay Shore, N. Y.	100
	WJBI	Red Bank, N. J.	100
	WJBU	Lewisburg, Pa.	100
	WJBY	Gadsden, Ala.	50
	WJW	Mansfield, Ohio	100
	WLCI	Ithaca, N. Y.	50
	WLSI	Cranston, R. I.	100
	WMAN	Columbus, Ohio	50
	WMBG	Richmond, Va.	100
	WMBR	Tampa, Fla.	100
	WOCL	Jamestown, N. Y.	25
	WOMT	Manitowoc, Wis.	100
	WPAW	Pawtucket, R. I.	100
	WRBQ	Greenville, Miss.	100
	WRBU	Gastonia, N. C.	100
	WSIX	Springfield, Tenn.	100
	WTAZ	Richmond, Va.	150
245.8	KFKU	Lawrence, Kansas	1000
	WCAE	Pittsburgh, Pa.	500
	WCAD	Canton, N. Y. (day)	500
	WREN	Lawrence, Kansas	1000
243.8	KFIO	Spokane, Wash. (day)	100
	KYA	San Francisco, Calif.	1000
	WBIS	Quincy, Mass.	500
	WFBM	Indianapolis, Ind.	1000
	WNAC	Boston, Mass.	500
	WPSC	State College, Pa. (day)	500
	WSBT	South Bend, Ind.	500
241.8	KTAT	Fort Worth, Texas	1000
	WGHP	Fraser, Mich.	750
	WJAD	Waco, Texas	1000
	WQAM	Miami, Fla.	750
	WRBC	Valparaiso, Ind. (day)	500
239.9	KEJK	Los Angeles, Calif.	500
	KFMX	Northfield, Minn.	1000
	KFOX	Long Beach, Calif.	1000
	KIDO	Boise, Idaho	1000
	KXL	Portland, Oregon	500
	WAAM	Newark, N. J.	500
	WCAL	Northfield, Minn.	1000
	WGCP	Newark, N. J.	250
	WGMS	St. Paul-Minn., Minn.	1000
	WLB	Minneapolis, Minn.	500
	WODA	Paterson, N. J.	1000
	WRHM	Minneapolis, Minn.	1000
238	KOIL	Council Bluffs, Iowa	1000
	KRGV	Harlingden, Texas	500
	KWWG	Brownsville, Texas	500
	WJAX	Jacksonville, Fla.	1000
	WLBW	Oil City, Pa.	500
236.1	KFUM	Colorado Springs, Colo.	1000
	KGCA	Decorah, Iowa (day)	50
	KOL	Seattle, Wash.	1000
	KTW	Seattle, Wash.	1000
	KWLC	Decorah, Iowa (day)	100
	WASH	Grand Rapids, Mich.	250
	WDSU	New Orleans, La.	1000
	WEAI	Ithaca, N. Y. (day)	500
	WFBR	Baltimore, Md.	250
	WOL	Washington, D. C. (day)	150
	WOOD	Grand Rapids, Mich.	500
234.2	WCAM	Camden, N. J.	500
	WCAP	Asbury Park, N. J.	500
	WDAY	West Fargo, N. D.	1000
	WDOD	Chattanooga, Tenn.	500
	WEBC	Superior, Wis.	1000
	WOAX	Trenton, N. J.	500
	WRR	Dallas, Texas	500
232.4	KDYL	Salt Lake City, Utah	1000
	KFUL	Galveston, Texas	1000
	KLCN	Blytheville, Ark. (day)	50
	KTSA	San Antonio, Texas	1000
	WJAS	Pittsburgh, Pa.	1000
	WNBZ	Saranac Lake, N. Y. (day)	50
230,6	KFH	Wichita, Kansas	500
	KFJR	Portland, Oregon	500
	KGEF	Los Angeles, Calif.	1000
	KTBI	Los Angeles, Calif.	750
	KTBR	Portland, Oregon	500
	WBBR	Rossville, N. Y.	1000
	WEVD	New York, N. Y.	500
	WHAP	New York, N. Y.	1000
	WHAZ	Troy, N. Y.	500
	WIBW	Topeka, Kansas	1000
228.9	KFBK	Sacramento, Calif.	100
	KFGQ	Boone, Iowa	100
	KFJY	Fort Dodge, Iowa	100
	KFPL	Dublin, Texas	15
	KFPM	Greenville, Texas	15
	KFUP	Denver, Colo.	100
	KFXJ	Edgewater, Colo.	50
	KFXR	Oklahoma City, Okla.	100
	KGEZ	Kalispell, Mont.	100
	KGHG	McGehee, Ark.	50
	KMED	Medford, Oregon	50
	KRMD	Shreveport, La.	50
	KTSL	Shreveport, La.	50
	KWCR	Cedar Rapids, Iowa	100
	WAGM	Royal Oak, Mich.	50
	WBMH	Detroit, Mich.	100
	WBOW	Terre Haute, Ind.	100
	WBRE	Wilkes-Barre, Pa.	100
	WCLS	Joliet, Ill.	100
	WDAH	El Paso, Texas	100
	WEBR	Buffalo, N. Y.	100
	WEHS	Evanston, Ill.	100

Wave (Meters)	Radio Call Letters	BROADCASTING STA. Location	Power (Watts)
	WFBG	Altoona, Pa.	100
	WFDF	Flint, Mich.	100
	WFKD	Philadelphia, Pa.	50
	WGAL	Lancaster, Pa.	15
	WGH	Newport News, Va.	100
	WHBP	Johnstown, Pa.	100
	WHFC	Cicero, Ill.	100
	WIBU	Poynette, Wis.	100
	WJAK	Kokomo, Ind.	50
	WKAV	Laconia, N. H.	50
	WKBB	Joliet, Ill.	100
	WKBC	Birmingham, Ala.	10
	WKBI	Chicago, Ill.	50
	WKBS	Galesburg, Ill.	100
	WLBC	Muncie, Ind.	50
	WMBL	Lakeland, Fla.	100
	WNAT	Philadelphia, Pa.	100
	WNBH	New Bedford, Mass.	100
	WNBJ	Knoxville, Tenn.	50
	WOBT	Union City, Tenn.	15
	WRAW	Reading, Pa.	100
	WRBI	Tifton, Ga.	20
	WRK	Hamilton, Ohio	100
	WSAJ	Grove City, Pa.	100
227.1	KID	Idaho Falls, Idaho	250
	KGHF	Pueblo, Colo.	250
	KGIQ	Twin Falls, Idaho	250
	WADC	Akron, Ohio	1000
	WSMB	New Orleans, La.	500
225.4	KSCJ	Sioux City, Iowa	1000
	WDRC	New Haven, Conn.	500
	WSAI	Cincinnati, Ohio	500
	WTAQ	Tnshp. of Wash., Wis.	1000
223.7	KFPW	Sulphur Sp'gs., Ark (day)j.	50
	KMO	Tacoma, Wash.	500
	KVI	Des Moines, Wash.	1000
	WSPD	Toledo, Ohio	500
222.1	KWK	St. Louis, Mo.	1000
	WBNY	New York, N. Y.	250
	WCDA	New York, N. Y.	250
	WKBQ	New York, N. Y.	250
	WMSG	New York, N. Y.	250
220.4	KFBB	Harve, Mont.	250
	KGB	San Diego, Calif.	250
	KGIR	Butte, Mont.	250
	WGES	Chicago, Ill.	500
	WJKS	Gary, Ind.	500
	WLEX	Boston, Mass.	500
	WMAF	South Dartmouth, Mass.	500
	WQBC	Utica, Miss.	300
218.8	KCRC	Enid, Okla.	100
	KFBL	Everett, Wash.	50
	KFJI	Astoria, Oregon	50
	KFJM	Grand Forks, N. D.	100
	KFJX	Fort Worth, Texas	100
	KFLX	Galveston, Texas	100
	KGAR	Tucson, Arizona	100
	KGBX	St. Joseph, Mo.	100
	KGCI	San Antonio, Texas	100
	KGDA	Dell Rapids, S. D.	50
	KGER	Long Beach, Calif.	100
	KGFG	Oklahoma City, Okla.	100
	KGFL	Raton, New Mexico	50
	KGGM	Albuquerque, N. Mex.	100
	KGKL	San Angelo, Texas	100
	KGRC	San Antonio, Texas	100
	KIT	Yakima, Wash.	50
	KLO	Ogden, Utah	100
	KOH	Reno, Nevada	100
	KOOS	Marshfield, Oregon	50
	KRE	Berkeley, Calif.	100
	KVL	Seattle, Wash.	100
	KWKC	Kansas City, Mo.	100
	KZM	Oakland, Calif.	100
	WBBL	Richmond, Va.	100
	WCBM	Baltimore, Md.	100
	WELK	Philadelphia, Pa.	100
	WFBJ	Collegeville, Minn.	100
	WGL	Fort Wayne, Ind.	100
	WHBD	Bellefontaine, Ohio	100
	WHBQ	Memphis, Tenn.	100
	WHDF	Calumet, Mich.	100
	WIBM	Jackson, Mich.	100
	WJBK	Ypsilanti, Mich.	100
	WJBO	New Orleans, La.	100
	WMBO	Auburn, N. Y.	100
	WRAK	Erie, Pa.	50
	WRBT	Wilmington, N. C.	50
	WSVS	Buffalo, N. Y.	50
217.3	KQV	Pittsburgh, Pa.	500
	KSO	Clarinda, Iowa	1000
	WCSO	Springfield, Ohio	500
	WKBH	LaCrosse, Wis.	1000
215.7	KFPY	Spokane, Wash.	500
	KLRA	Little Rock, Ark.	1000
	KOY	Phoenix, Arizona	500
	KUOA	Fayetteville, Ark.	1000
	KWSC	Pullman, Wash.	500
	WDGY	Minneapolis, Minn.	500
	WHDI	Minneapolis, Minn.	500
	WHK	Cleveland, Ohio	1000
214.2	KPWF	Westminster, Calif.	10000
	WBBC	Brooklyn, N. Y.	500
	WCGU	Brooklyn, N. Y.	500
	WCMA	Culver, Ind.	500
	WKBF	Indianapolis, Ind.	500
	WLTH	Brooklyn, N. Y.	500
	WSDA	Brooklyn, N. Y.	500
	WSGH	Brooklyn, N. Y.	500
212.6	KFLV	Rockford, Ill.	500
	KGRS	Amarillo, Texas	1000
	WBCM	Hampton Tnshp., Mich.	500
	WDAG	Amarillo, Texas	250
	WHBL	Sheboygan, Wis.	500
211.1	KFIF	Portland, Oregon	500
	KFIZ	Fond du Lac, Wis.	100
	KFQU	Holy City, Calif.	100
	KFQW	Seattle, Wash.	100
	KFXD	Jerome, Idaho	50
	KFXY	Flagstaff, Arizona	100
	KFYO	Abilene, Texas	100
	KGCX	Vida, Montana	100
	KGFF	Alva, Okla.	100
	KGFJ	Los Angeles, Calif.	100
	KGFW	Ravenna, Neb.	50
	KGGC	San Francisco, Cal.	50
	KGIW	Trinidad, Colo.	100
	KGIX	Las Vegas, Nev.	100
	KGKX	Sandpoint, Idaho	10
	KOCW	Chickasha, Okla.	105
	KORE	Eugene, Oregon	100
	KTAP	San Antonio, Texas	100
	KTUE	Houston, Texas	0
	KVOA	Tucson, Ariz.	505
	KXRO	Seattle, Wash.	70
	WEDH	Erie, Pa.	35
	WHDL	Tupper Lake, N. Y.	10
	WHIS	Bluefield, W. Va.	100
	WIAS	Ottumwa, Iowa	100
	WIBR	Steubenville, Ohio	50
	WILM	Wilmington, Del.	100
	WKBP	Battle Creek, Mich.	50
	WLBF	Kansas City, Mo.	100
	WLEY	Lexington, Mass.	100
	WMBC	Detroit, Mich.	100
	WMBH	Joplin, Mo.	100
	WMRJ	Jamaica, N. Y.	10
	WPOE	Patchogue, N.Y.	30
	WQBZ	Weirton, W. Va.	60
	WSSH	Boston, Mass.	100
	WTBO	Cumberland, Md.	50
209.7	WBAK	Harrisburg, Pa. (day)	500
	WBRL	Tilton, N. H.	500
	WCAH	Columbus, Ohio	500
	WGBC	Memphis, Tenn.	500
	WNBR	Memphis, Tenn.	500
208.2	KLS	Oakland, Calif. (day)	100
	WABO	Rochester, N. Y.	500
	WCBA	Allentown, Pa.	250
	WHEC	Rochester, N. Y.	500
	WMBD	Peoria, Ill.	500
	WNRC	Greenboro, N. C.	250
	WOKO	Mt. Beacon, N. Y.	500
	WSAN	Allentown, Pa.	250
	WTAD	Quincy, Ill.	500
206.8	KTBS	Shreveport, La.	500
	WBMS	Fort Lee, N. J.	250
	WFJC	Akron, Ohio	500
	WIBS	Elizabeth, N. J.	250
	WJAY	Cleveland, Ohio	500
	WKBO	Jersey City, N. J.	250
	WNJ	Newark, N. J.	250
	WSAR	Portsmouth, R. I.	250
	WTFI	Toccoa Falls, Ga.	250
205.4	KSTP	St. Paul, Minn.	10000
	WJSV	Mt. Vernon Hills, Va.	10000
204	KFJF	Oklahoma City, Okla.	5000
	KGA	Spokane, Wash.	5000
	WKBW	Buffalo, N. Y.	5000
	WRUF	Gainerseville, Fla.	5000
202.6	WJAZ	Chicago, Ill.	5000
	WCKY	Villa Madonna, Ky.	5000
	WORD	Chicago, Ill.	5000
	WSOA	Deerfield, Ill.	5000
201.2	WBAW	Nashville, Tenn.	5000
	WLAC	Nashville, Tenn.	5000
199.9	KDB	Santa Barbara, Calif.	100
	KGDR	San Antonio, Calif.	100
	KGEI	San Angelo, Texas	100
	KGHI	Little Rock, Ark.	100
	KGHX	Richmond, Texas	50
	KGKB	Brownwood, Texas	100
	KPJM	Prescott, Arizona	100
	KUJ	Longview, Wash.	10
	KWBS	Portland, Oregon	15
	KWTC	Santa Ana, Calif.	100
	WAFD	Detroit, Mich.	100
	WALK	Willow Grove, Pa.	50
	WCLB	Long Beach, N. Y.	100
	WHP	Harrisburg, Pa.	500
	WKBV	Brookville, Ind.	100
	WKBZ	Ludington, Mich.	50
	WLBX	Long Island City, N. Y.	100
	WLOE	Chelsea, Mass.	100
	WMBA	Newport, R. I.	100
	WMBJ	Wilkinsburg, Pa.	100
	WMBQ	Brooklyn, N. Y.	100
	WMES	Boston, Mass.	50
	WMPC	Lapeer, Mich.	100
	WNBF	Binghamton, N. Y.	50
	WOPI	Bristol, Tenn.	100
	WPSW	Philadelphia, Pa.	50
	WRBJ	Hattiesburg, Miss.	10
	WWRL	Woodside, N. Y.	100

List of Canadian Broadcast Calls

(By Wavelengths)

556	CKX	Brandon, Man.	500
517	CHCT	(See CKCL)	
	CHMA	Edmonton, Alta.	250
	CHNC	(See CKNC)	
	CJBC	Toronto, Ont.	
	CJCA	Edmonton, Alta.	500
	CJSC	(See CKCL)	
	CKCL	Toronto, Ont.	500
	CKNC	Toronto, Ont.	500
	CKUA	Edmonton, Alta.	500
	CNRJ	(See CJCA)	
500	CFCH	Iroquois Falls, Ont.	250
	CHRC	Quebec, Que.	25
	CJRM	Moose Jaw, Sask	500
	CJRW	Fleming, Sask.	500
	CKCI	Quebec, Que.	23
	CKCV	Quebec, Que.	50
	CNRO	(See CKCV)	
476	CFCT	Victoria, B. C.	500
	CJGX	Yorkton, Sask.	500
	CNRA	Moncton, N. B.	500
434	CFAC	Calgary, Alta.	500
	CFCN	Calgary, Alta.	1800
	CHCA	(See CJCJ)	
	CJCJ	Calgary, Alta.	250
	CKCO	Ottawa, Ont.	100
	CNRC	(See CFAC)	
	CNRO	Ottawa, Ont.	500
	VAS	Louisburg, N. S.	
411	CHLS	(See CKCD)	
	CHYC	Montreal, Que.	750
	CKAC	Montreal, Que.	1200
	CKCD	Vancouver, B. C.	50
	CKFC	Vancouver, B. C.	50
	CKMO	Vancouver, B. C.	50
	CKWX	Vancouver, B. C.	100
	CNRM	(See CKAC)	
384	CJCB	Sydney, N. S.	50
	CKY	Winnipeg, Man.	5000
357	CFCA	Toronto, Ont.	500
	CFCL	(See CKLC)	
	CJBC	Toronto, Ont.	
	CKLC	Red Deer, Alberta	1000
	CKOW	(See CFCA)	
341	CHCS	Hamilton, Ont.	10
	CHML	Mt. Hamilton, Ont	50
	CKOC	Hamilton, Ont.	100
337	CFBO	St. Johns, N. B.	50
329	CFQC	Saskatoon, Sask.	500
	CJGC	London, Ont.	500
	CJHS	Saskatoon, Sask.	250
	CNRS	(See CFQC)	
322	CHNS	Halifax, N. S.	500
312	CFCY	Charlottetown, P. E. I.	100
	CFRB	Toronto, Ont.	1000
	CJBR	(See CKCK)	
	CHCK	Charlottetown, P. E. I.	30
	CHWC	Regina, Sask.	500
	CJBC	Toronto, Ont.	
	CKCK	Regina, Sask.	500
	CKGW	Bowmanville, Ont.	5000
	CNRR	(See CKCK)	
297	CFLC	Prescott, Ont.	50
	CKCR	Brantford, Ont.	50
	CKSH	St. Hyacinthe, Que.	50
291	CFCF	Montreal, Que.	1650
	CJOR	Sea Island, B. C.	50
	CNRM	(See CFCF)	
	CNRV	Vancouver, B. C.	500
268	CFRC	Kingston, Ont.	500
	CFJC	Kamloops, B. C.	15
	CHGS	Summerside, P. E. I.	25
	CJOC	Lethbridge, Alta.	50
	CKPR	Midland, Ont.	50
248	CFCO	Chatham, Ont.	25
	CFNB	Fredericton, N. B.	50
	CHWK	Chilliwack, B. C.	5
	CKMC	Cobalt, Ont.	15
	CKPC	Preston, Ont.	25

Short-Wave Stations of the World

Alphabetically, by Countries and by Call Letters

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
	AFRICA		
AIN	Casablanca, Morocco	51.00	
8KR	Constantine, Tunis	42.80	
JP	Johannesburg, U.S. Africa	25.00	
7LO	Nairobi, Kenya	33.50	2000
	AUSTRALIA		
2BL	Sydney	32.50	
2FC	Sydney	28.50	
2ME	Sydney	28.50	
3AR	Melbourne	55.00	
3LO	Melbourne	31.55	
6AG	Perth, West Australia	32.90	
6WF	Perth	104.50	
AGAG	Perth	41.7	
	AUSTRIA		
OHK2	Vienna	70.00	
EATH	Vienna	37.00	
	Vienna	22.20	
	BELGIUM		
EB4A2	Brussels	42.00	300
	BRITISH GUIANA		
BZL	Georgetown	43.80	200
	CANADA		
CF	Drummondville, Que.	32.00	
CJRX	Winnipeg, Man.	25.58	2000
VAS	Louisburg, N. S.	28.00	
	COSTA RICA		
NRH	Heredia	30.30	7½
	DANTZIG		
EK4ZZZ	Dantzig	40.00	
	DENMARK		
D7MK	Copenhagen	32.05	500
D7RL	Copenhagen	42.12 and 84.24	250
	ENGLAND		
5SW	Chelmsford	25.53	15000
2NM	Caterham	32.50	
GBS	Rugby	24.40	
	FINLAND		
	Helsingfors (Helsinki)	31.50	
	FRANCE		
F8GC	Paris ("Radio LL")	61.00	500
F8AV	Nogent	80.00	500
Radio Vitus	Paris	37.00	1500
Eiffel Tower	Paris (time signals)	32.50	
YR	Lyons ("Radio Lyon")	40.20	250
	Agen	30.75	
YN	Lyons	58.00	3000
	Nancy	15.50	500
FW4	Ste. Assise	24.50	
	GERMANY		
AFI	Konigswusterhausen	14.00	
AFL	Hamburg	70.00 and 52.00	
AFT	Konigswusterhausen	14.00	
AFU	Konigswusterhausen	14.00	
AFK	Berlin (Doberitz)	37.56, 75.36	
HEA	Nauen	11.00	
AGC	Berlin	17.20	
AGJ	Nauen	56.70	

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
	GERMANY—(Continued)		
AGK	Nauen	11.00	
LA	Langenberg	43.90	
POF	Nauen	11.00	
POZ	Nauen	18.10	
	Stuttgart	41.00	
	HOLLAND		
PCJ	Eindhoven	31.4	30000
PCKK	Kootwijk	16.00	
PCL	Kootwijk	18.00	32000
PCMM	Ymuiden	46.50	
PCPP	Kootwijk	16.50	
PCRR	Kootwijk	37.00	
PCTT	Kootwijk	21.00	
PCUU	The Hague	37.00	
PHI	Eindhoven	16.88	
PHOBI	Huize	30.2	
	ITALY		
I1AX	Rome	20.00, 40.00	300
IAY	Placenza	20.00, 45.00	50

IT IS impossible to obtain a complete and accurate list of the short-wave stations of the world. For this reason, some of the notations here may be incorrect, and we would appreciate receiving any corrections from readers or stations, so that we can keep the list as accurate as possible.

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
	JAPAN		
JFAB	TAIPEH, Formosa	39.50	
JHBB	Ibarakiken (Hirasio)	37.50	2000
JIPP	Tokio	20.00	
JKZB	Tokio	20.00	
JOAK	Tokio. 30.00, 60.00 35.00,	70.00	500
IAA	Iwatsuki	40.00	
	JAVA		
PLE, PLF	Bandoeng	15.74 and 17.00	
	MEXICO		
XC51	Mexico City	44.00	
	MOROCCO		
AIN	Casablanca	51.00	
	NORWAY		
LCHO	Oslo	33.00	
LGN	Bergen	31.25, 30.00	
	U. S. S. R. (RUSSIA)		
RDRL	Leningrad	28.50	
RDW	Moscow	83.00	
RFM	Khabarovsk (Siberia)	70.20	12000
RFN	Moscow	50.00	
RA19	Tomsk (Siberia)	37.00	
	SPAIN		
EAM	Madrid	30.70	
EAR55	Barcelona		

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
	SWEDEN		
SAS	Karlsborg	52.50	
SAA	Karlskrona	44.40	
	Motala	99 and 41.45	1000
SAJ	Karlsborg	47.00	
SMHA	Stockholm	41.00	
	SWITZERLAND		
EH90C	Berne	32.00	
EH9XD	Zurich	85.00 and 32.00	
	UNITED STATES		
KDKA (W8XK, (W8XS, W8XP-portable	East Pittsburgh, Pa.	62.50, 42.75, 25.24	40000
KEJK (W6XAN)	Los Angeles, Calif.	105.90	250
KEWE	Bolinas, Calif.	14.10	
KFPY (W7XAB)	Spokane, Wash.	105.90	100
KFQU (W6XBH)	Holy City, Calif.	31.00	50
KFQZ (W6XAL)	Hollywood, Calif.	108.20	50
KFVD (W6XBX)	Culver City, Calif.	105.00	50
KFWB (W6XBR)	Los Angeles, Calif.	105.00, 40.00	50
KFWO (W6XAD)	Avalon, Calif.	53.07	100
KGER (W6XBV)	Long Beach, Calif.	48.86	
KGB	San Diego, Calif.	65.18	
KGDE	Barrett Minn.	40.00	50
KGO (W6XAX, W6XN)	San Francisco, Calif.	10 to 40	10000
KHJ (W6XAU)	Los Angeles, Calif.	104.10	50
KJBS (W6XAR)	San Francisco, Cal.	61.00	50
KJR (W7XC, W7XO)	Seattle, Wash.	105.20	250
KMOX	St. Louis, Mo.	49.00	15
KMTR	Los Angeles, Calif.	108.20	250
KNRC (W6XAF)	Santa Monica, Cal.	108.20	100
KNX (W6XA)	Los Angeles, Calif.	107.10	100
KOIL (W9XU)	Council Bluffs, Iowa	61.06	500
KWE-KEWE	Bolinas, Calif.	14.10	
KWJJ (W7XAO)	Portland, Oregon	53.54	100
NAA	Arlington, Va.	48.99 and 31.39	
WAAM (W2XBA)	Newark, N. J.	65.18	50
WABC (W2XE)	Richmond Hill, N.Y.	58.50	500
WAJ	Rocky Point, N. Y.	22.48	
WBRL (W1XY)	Tilton, N. H.	109.00	250
WBZ	Springfield, Mass.	70.00	
WCFL	Chicago, Ill.	37.24	
WCGU (W2XBH)	Brooklyn, N. Y.	54.00	150
WCSH (W1XAB)	Portland, Maine	63.79	250
WCX	Pontiac, Mich.	32.00	75
WEAJ	Rocky Point, N. Y.	22.48	
WEAO (W8XJ)	Columbus, Ohio	54.02	25
WGY (W2XAF)	Schenectady, N.Y.	31.48	
(W2XAD)	Schenectady, N.Y.	19.56, 5.00	
WHK (W8XF)	Cleveland, Ohio	66.04	500
WJR-WCX (W8XAO)	Pontiac, Mich.	32.00	
W1Z	New Brunswick, N. J.	43.45	
WJZ (W3XAL)	New York, N. Y.	49.18 to 13.95	30000
WLW (W8XAL)	Cincinnati, Ohio	52.02	250
WNAL (W9XAB)	Omaha, Neb.	105.00	50
WNBT	Elgin, Ill. (Time Sig.)	35.50	500
WND	Ocean Township, N. J.	46.48	
WOR (W2XAQ)	Kearny, N. J.	65.40	50
WOWO	Fort Wayne, Ind.	22.80	1000
WRNY (W2XAL)	New York, N. Y.	30.91	500
WSM (4XD)	Nashville, Tenn.	31.43	
WTFF	Mt. Vernon, Va.	56.00	

(Several short waves are used for transatlantic telephony. This is private business, not broadcasting.)

Foreign Radio Broadcast Stations

Including U. S. Possessions

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
	ALASKA		
KFIU	Juneau	225.4	10
KFQD	Anchorage	344.6	100
KGBU	Ketchikan	399.8	500
	ALGERIA		
8DB	Algiers	310	100
	ARGENTINA		
LOJ	Buenos Aires	270	1000
LOL	Buenos Aires	236	2000
LON	Buenos Aires	210	5000
LOO	Buenos Aires	252	1000
LOP	La Plata	425	1000
LOQ	Buenos Aires	261.8	3000
LOR	Buenos Aires	344.8	1000
LOS	Buenos Aires	291.2	5000
LOT	Buenos Aires	400	1000
LOU	Mendoza	280	500
LOV	Buenos Aires	361.5	1000
LOW	Buenos Aires	303	1000
LOX	Buenos Aires	380	1000
LOY	Buenos Aires	315.2	1000
LOZ	Buenos Aires	330	1000
B2	Buenos Aires	275	100
D3	Buenos Aires	253.3	100
F1	Sante Fe	279	30
F2	Rosario	270	100
H5	Cordoba	275	100
H6	Cordoba	250	20
M6	Mendoza	348	10

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
	AUSTRALIA		
2BE	Sydney	326	20
2BL	Sydney	353	1000
2FC	Sydney	442	2000
2GB	Sydney	326	1500
2HD	Newcastle	288	20
2KY	Sydney	280	300
2ME	Sydney	28.5	
2MK	Bathurst	275	250
2UW	Northbridge	263	100
2VE	Sydney	297	50
2WA	Sydney	462	100
3AR	Melbourne	484	320
3EO	Mildura	286	20
3LO	Melbourne	371	1000
3UZ	Melbourne	319	20
3WR	Melbourne	303	20
4GM	Brisbane	278	50
4GR	Toowomba	294	20
4MB	Brisbane	337	250
4QG	Brisbane	385	1000
4RN	Rockhampton	323	100
5CL	Adelaide	392	1000
5DN	Adelaide	313	100
6AG	Perth	32.9	
6WF	Perth	1250	1000
	AUSTRIA		
ORV	Vienna	517.2	14000
	Graz	365.8	500
	Innsbruck	294.1	500
	Klagenfurt	272.7	500

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
	Linz	254.2	500
	Vienna	577	
	BELGIUM		
BAV	Brussels	508.5	1500
	Antwerp	265.5	100
	Brussels	230	
	Ghent	275	
	Liege	205	100
	Liege	294.1	100
	BOLIVIA		
	La Paz	175	50
	La Paz	300	50
	BRAZIL		
RSR	Porto Alegre	381	80
SKV	Bahai	600	50
SQAA	Rio de Janeiro	400	2000
SQAB	Rio de Janeiro	310	500
SQAD	Bahia	445	50
SQAF	Curytiba	240	8
SQAG	Sao Paulo	350	1000
SQAI	Santos	280	10
SQAJ	Rio de Janeiro	260	500
SQAK	Ribeirao Preto	350	
SQAY	Juiz de Fora	380	200
SQBO	Sao Paulo	225.4	1000
SQBE	Bahia	24	
	Para	34	
	Pernambuco	310	
	Sorocaba	425	

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
	CANARY ISLANDS		
EAR5	Las Palmas	250	200
	CEYLON		
	Colombo	800	1500
	CHILE		
CMAC	Santiago	360	1000
CMAD	Santiago	320	1000
CMAE	Santiago	280	100
CMAI	Concepcion	345	1500
CMAK	Temuco	245	100
CMAO	Antofagasta		
CMAT	Tacna	550	200
	Asuncion	12	
	Valparaiso	400	50
	CHINA		
CEC	Tientsin	280	50
COHB	Harbin	445	
COMK	Mukden	425	2000
COTN	Tientsin	480	500
GOW	Victorio	300	1500
KRC	Shanghai	342	250
RSC	Shanghai	342	250
VPS3	Victoria	800	
XOL	Tientsin	480	500
	Shanghai	342	250
	CHOSEN		
JODK	Seoul	357	1000
	CUBA		
CMC	Havana	347	500
PWIH	Havana	376	500
1AZ	Guanajay	275	30
2AB	Havana	250	10
2AZ	Havana	334	30
2BB	Havana	250	15
2CP	Havana	280	10
2FG	Hershey	226	20
2HP	Havana	205	200
2JF	Mariano	252	15
2JP	Havana	245.5	15
2JL	Mariano	294	7½
2LC	Havana	303	30
2MA	Mariano	277	50
2MG	Havana	284	20
2OH	Havana	300	15
2OK	Havana	350	100
2OL	Havana	257	100
2RK	Havana	326	50
2SE	Havana	211	10
2SW	Mariano	274	7½
2TW	Havana	270	30
2UF	Havana	228	100
2WX	Havana	261	150
2XA	Havana	230	200
2XX	Havana	275	10
5DW	Matanzas	270	
5EV	Colon	360	100
6BY	Cienfuegos	260	200
6EV	Caibarien	250	50
6HS	Sagua la Grande	200	10
6JQ	Cienfuegos	275	10
6KC	Cienfuegos	240	
6KP	Sancti Spiritus	280	20
6KW	Tuinicu	368	100
6LO	Caibarien	325	250
6MN	Santa Clara	210	20
6XJ	Tuinicu	278	
6YR	Camajuani	200	20
7AZ	Camaguey	225	10
7BY	Ciego de Avila	235	20
7EV	Camaguey	190	
7FU	Ciego de Avila	200	15
7GT	Camaguey Armanda Vaquer	195	5
7HS	Ciego de Avila	192	15
7IR	Ciego de Avila	193	
7LO	Camaguey	230	20
7NM	Nuevitos	264	20
7SR	Elia	350	300
8BY	Santiago	150	30
8HS	Santiago	200	30
8IR	Santiago	190	20
8KP	Caney	180	100
8KW	Santiago	250	15
8LC	Caney	300	100
	CZECHOSLOVAKIA		
OKB	Brunn	441.2	2400
OKK	Kosice	263	2000
OKP	Prague	384.9	5000
OKR	Bratislava	300	500
	Kosice	1870	
	DENMARK		
	Copenhagen	339.8	1000
	Kalundborg	1535	7500
	Ryvang	1150	1000
	Soro	1153.8	1500
	DUTCH EAST INDIES		
ANE	Bandoeng	310	6
ANH	Malabor		
JFC	Batavia	220 7	40
	Surabaya	140	500
	Surabaya	175	
	EGYPT		
SRE	Cairo	225	
	ESTHONIA		
	Tallinn	408	700
	Tallinn	1200	100
	FINLAND		
3NB	Tammerfors (Tampere)	400	250
	Bjorneborg	254.2	100
	Helsingfors	500	1000
	Helsingfors	240	2000
	Jacobstad (Pietersarrki)	275	200
	Jyvaskyla	297	200
	Lahtis	1525	40,000
	Lahtis	318	180
	Mikeli	566	250
	Uleaborg	250	250
	Viborg	240	750
	FRANCE		
2BD	Agen	297	500
5NG	Paris	340.9	500
8AJ	Paris	1780	100
8GF	Strasbourg	222.2	250
F8GC	Paris	350	500
CFR	Paris	1750	3000
FL	Paris	458	1000
FPTT	Paris	238	200
MRD	Toulouse	260	1000
YN	Lyon	480	1000

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
YR	Lyon	290	5000
	Agen	30.75	
	Beziers	180	500
	Biarritz	198	250
	Bordeaux	419	1500
	Fecamp	200	
	Grenoble	416	150
	Juan-les-Pins	246	500
	Lille	246	500
	Limoges	285	500
	Marseilles	300	1000
	Mont-de-Marsan	390	300
	Montpelier	238	200
	Nancy	15.5	
	Nice	246	
	Nimes	249	
	Paris	308	250
	Paris	350	
	Paris	37	
	Rennes	294	1500
	Toulouse	389.6	2000
	GERMANY		
AB	Berlin	566	2000
AFT	Berlin	1648	8000
BMN	Bremen	387.1	1500
HA	Hamburg	391.6	4000
KAV	Norddeich	1839	
LA	Langenberg	462.2	25000
LP	Frankfort-on-the-Main	421 3	4000
MR	Leipzig	361.9	4000
MS	Muenster	265.5	1500
OKP	Stuttgart	374.1	4000
SMXQ	Cologne	263.2	4000
	Aix-la-Chapelle	455.9	750
	Augsburg	566	700
	Berlin	438 9	800
	Berlin	475.4	4000
	Berlin	2525	5000
	Breslau	321 2	5000
	Danzig	272 7	
	Dortmund	283	750
	Dresden	387 1	700
	Elberfeld	468.8	750
	Flensburg	219	
	Freiburg im Breisgau	577	750
	Gleiwitz	326.4	750
	Hanover	566	750
	Kaiserlautern	204.1	4000
	Kassel	250	750
	Kiel	250	750
	Koenigsberg	280.4	4000
	Munich	536.7	4000
	Nuremberg	240	4000
	Schoerbeek	230	
	Stettin	236.2	500

THIS listing of foreign broadcast stations of the world, up to the present listing, is correct, although undoubtedly some changes will be made after going to press. In many cases, reliable information about programs, wave length and power of the stations cannot be obtained even from the stations themselves.

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
	HAITI		
HHK	Port-au-Prince	361 2	1000
	HAWAII		
KGU	Honolulu	270.1	600
KGHB	Honolulu	227.1	250
	HUNGARY		
MT1	Budapest	555.6	2000
MT2	Budapest	1050	400
MT3	Budapest		12000
	ICELAND		
G2SH	Akureyri	192	
	Reykjavik	333.3	500
	INDIA		
2AX	Bombay	320	50
2FV	Bombay	387	100
2GR	Madras	400	200
2HZ	Rangoon	350	40
7BY	Bombay	357.1	3000
7CA	Calcutta	370.4	4000
VUB	Bombay	357 1	
VUC	Calcutta	370.4	
VPB	Colombo	800	
	IRISH FREE STATE		
2RN	Dublin	319.1	1500
6CK	Cork	400	1000
	ITALY		
1IAX	Rome	45	
1MI	Milan	315.8	7000
1NA	Naples	333.3	1500
1RO	Rome	449	3000
	Genoa		6000
	JAPAN		
JOAK	Tokyo	375	1000
JOBK	Osaka	385	1000
JOCK	Nagoya	360	1000
JODK	Keijo*	357	1000
JOFK	Hiroshima	353	10000
JOGK	Kumamoto	380	2000
JOHK	Sandai	390	1000
JOIK	Sapporo	361	1000
	KENYA		
7LO	Nairobi	35	
		400	
	KWANTUNG		
JQAK	Dairen	395	5000
	LATVIA		
KCX	Riga	526.3	2000
	LITHUANIA		
	Kuanas	2000	
	Kovno	2000	
	LUXEMBURG		
LOAA	Luxemburg	217.4	250
	MEXICO		
CYA	Mexico City	300	500

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
CYB	Mexico City	275	500
CYC	Vera Cruz	337	50
CYD	Vera Cruz	250	500
CYF	Oaxaca	265	100
CYH	Mexico City	375	100
CYH	Monterey		
CYJ	Mexico City	400	2000
CYL	Mexico City	400	500
CYM	Torreon	225	1500
CYO	Mexico City	425	100
CYQ	Tampico	322	100
CYR	Mazatlan	475	250
CYS	Monterey	311	250
CYU	Pueblo	312	100
CYX	Mexico City	325	500
CYY	Merida	549	100
CYZ	Tampico	20	
CXE	Mexico City	350	500
CZF	Chihuahua	310	250
XEA	Guadalajara	250	10
XES	Cindad Lerdo	250	
XFC	Jalapa	475	
XFF	Chihuahua	325	
	MOROCCO		
CNO	Casablanca	305	25
	Rabat	414	
	NETHERLANDS		
PCFF	De Bilt	1470	1250
PCLL	Kootwijk	184	25,000
HDO	Hilversum	1060	1000
	Scheveningen	1875	2500
	Huizen	340.9	
		1840	
	NETHERLANDS EAST INDIES		
	Soerabaya	90	
	NEW ZEALAND		
1YA	Auckland	420	500
1YC	Whangerei	250	15
1ZB	Auckland	275	
1ZQ	Auckland	253	50
2YA	Wellington	420	5000
2YK	Wellington	295	60
2ZA	Wanganui	500	
2ZM	Gisborne	260	500
3AC	Christchurch	400	500
3YA	Christchurch	306	500
4YA	Dunedin	380	110
4ZB	Otago	300	
4ZL	Dunedin	252	
4ZM	Dunedin	277.8	
22F	Palmerston	280	
	NORWAY		
OSLO	Oslo	270.4	1500
	Aalesand	511	
	Bergen	370.4	
	Bergen	370.4	1500
	Fredrikstad	434.8	750
	Natodden	411	700
	Porsgrund	405	1000
	Riuken	447.8	250
	Stavanger	277.6	1500
	Tromso	500	
	Trondhjem	243.9	1000
	PERU		
OAX	Lima	360	1500
	PHILIPPINE ISLANDS		
KPM	Iliolo	400	500
KZIB	Manila	260	500
KZKZ	Manila	270	500
KZRQ	Manila	385	1000
	POLAND		
AXO	Warsaw	1111.1	8000
	Katowice	422	2000
	Krakow	422	1300
	Poznan	270.3	1500
	Wilna	435	
	PORTO RICO		
WKAQ	San Juan	322.4	500
	PORTUGAL		
PIAA	Lisboa	305	500
	ROUMANIA		
	Bucharest	401.6	
	SAN SALVADOR		
AQM	San Salvador	482	500
	SENEGAL		
	St. Louis	300	100
	SPAIN		
EAJ1	Barcelona	344.8	1000
EAJ2	Madrid	420	600
EAJ3	Cadiz	400	1000
EAJ7	Madrid	375	1200
EAJ8	San Sebastian	297	3000
EAJ9	Bilbao	434.8	1000
EAJ13	Barcelona	462	1000
EAJ16	Cartagena	330	1000
EAJ17	Seville	434.8	600
EAJ18	Almeria	320	1000
EAJ19	Oviedo (Cima)	280.4	200
EAJ22	Salamanca	500	500
EAJ25	Malaga	100	100
	STRAITS SETTLEMENTS		
1SE	Singapore	330	100
	SWEDEN		
SASA	Stockholm	454.5	1000
SASB	Goteborg	416.1	600
SASC	Malmo	260.9	600
SASD	Sundsvall	545.6	600
SASE	Boden	1190	600
SASF	Ostersund	720	600
SASG	Motala	1380	30000
SMRM	Uppsala	500	150
SMSB	Halmstad	215.8	200
SMSL	Hudiksvall	272.7	160
SMSM	Karlskrona	196	200
SMSN	Umea	229	200
SMSO	Varberg	297	300
SMTG	Kiruna	238.1	400
SMTI	Orebro	236.2	200
SMTJ	Kristinehamn	202.7	250
SMTS	Saffle	252.1	400
SMUC	Eskilstuna	250	200
SMUW	Linkoping	500	200
SMVV	Norkoping	275.2	250
SMXF	Gavle	204.1	200

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
SMXG	Karlstad	220.6	250
SMXO	Molmbergt	400	250
SMXQ	Trolhattan	278.8	400
SMYB	Boras	230.8	150
SMYE	Helsingborg	229	200
SMZA	Ormskoeldsvik	222.2	200
SMZD	Jonkopings	201.3	250
SMZK	Falun	335.3	500
SMZP	Uddevalla	294.1	500
	Hamar	555.8	—
	SWITZERLAND		
HBA	Berne	407	1500
HBI	Geneva	760	500
HBZ	Zurich	500	1500
HB2	Lausanne	850	600
HB3	Basel	1000	300
	TUNISIA		
TNU	Carthage	1850	5000
TUA	Tunis	1450–45	100
8KR	Constantine	42.8	
	TURKEY		
	Angora	1806	6000
	Osmanieh	1200	6000
	Stamboul	1200	15000
	UNION OF SOUTH AFRICA		
JB	Johannesburg	32	
		443.5	900
WAMG	Capetown	372	1200
	Durban	398	1200
	Pretoria	323	
	UNION OF SOVIET SOCIALIST REPUBLICS (Formerly Russia)		
RA1	Moscow	1450	40000
RA2	Moscow	450	500
RA4	Moscow	450	300
RA7	Ivanova-Vosnensensk	800	180
RA8	Bogorodsk	750	700
RA9	Sevastopol	900	250

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
RA11	Tiflis	870	4000
RA12	Voronezh	950	240
RA13	Nizhni-Novgorod	840	1800
RA14	Rostov-on-Don	820	4000
RA15	Sverdlovks	1050	500
RA16	Vel Ustjuk	620	1200
RA17	Vladivostok	480	1500
RA18	Minsk	860	1200
RA20	Stavropol	550	1200
RA21	Tomsk	300	150
RA22	Samara	900	1200
RA25	Orenburg	640	1000
RA26	Astrakham	700	1000
RA27	Tashkent	751	2000
RA30	Dneipropetrovsk	525	1000
RA32	Novorossisk	1117	4000
RA32	Saratov	420	200
RA34	Koursk	575	1000
RA38	Krasnodar	513	1000
RA39	Gomel	925	1200
RA40	Odessa	975	1200
RA41	Vologda	875	1200
RA42	Leningrad	1000	10000
RA43	Kharkov	475	
		1700	4000
RA44	Tver	690	1200
RA45	Kiev	775	1200
RA45	Baku	750	4000
RA46	Petrozavodsk	765	2000
RA47	Armavir	720	200
RA49	Erivan	1050	1200
RA51	Ulyanovsk	500	20
RA56	Artemovsk	790	1200
RA57	Irkutsk	1100	500
RA59	Leningrad	150	350
RA64	Petropavlovsk	350	45
RA67	Nalchik	1070	240
RA68	Smolensk	330	20
RA72	Smolensk	150	800
RA77	Stalino	730	1200
RDW.	Moscow	1450	12000
	UNITED KINGDOM		
2BD	Aberdeen	500	1500
2BE	Belfast	306.1	1500

Call Letters	BROADCAST STA. Location	Wave Length	Power (Watts)
2DE	Dundee	294	200
2EH	Edinburgh	288.5	500
2LO	London	297	200
2LS	Leeds	277.8	500
2LS	Bradford	252.1	200
2NM	Caterham	32.5	
2ZY	Manchester	384.6	1500
5GB	Daventry	323.2	25000
5IT	Birmingham	326.1	1500
5NG	Nottingham	275.2	200
5NO	Newcastle	312.5	1500
5PY	Plymouth	400	200
5SC	Glasgow	405.4	1500
5SW	Daventry	24	
5SX	Swansea	294	200
5WA	Cardiff	353	1500
5XX	Daventry	1600	16000
6BM	Bournemouth	491.8	1500
6FL	Sheffield	272.7	200
6KH	Hull	294	200
6LV	Liverpool	297	200
6ST	Stoke-on-Trent	294	200
6SW	Chelmsford	24	
	URUGUAY		
CWOA	Montevideo	428.4	1000
CWOF	Montevideo	300	100
CWOG	Montevideo	280	10
CWOH	Montevideo	300	50
CWOI	Salta	272	50
CWOJ	Salta	250	10
CWOK	Montevideo	260	50
CWOL	Montevideo	272	100
CWOM	Montevideo	265.5	20
CWON	Montevideo	256.5	200
CWOO	Montevideo	294	50
CWOR	Montevideo	350	500
CWOS	Montevideo	380	500
CWOW	Montevideo	500	
	VENEZUELA		
AYRE	Caracas	375	1000
	YUGOSLAVIA		
	Zagreb	309.2	100

Foreign Radio Broadcast Stations, Including U. S. Possessions

By Wave-Lengths

Wave Length (Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)
		ALASKA	
399.8	KGBU	Ketchikan	500
344.8	KFQD	Anchorage	100
225.4	KFIU	Juneau	10
		ALGERIA	
310	8DB	Algiers	100
		ARGENTINA	
425	LOP	La Plata	1000
400	LOT	Buenos Aires	1000
380	LOX	Buenos Aires	1000
361.5	LOV	Buenos Aires	1000
348	M6	Mendoza	10
344.8	LOR	Buenos Aires	1000
330	LOZ	Buenos Aires	1000
315.2	LOY	Buenos Aires	1000
303	LOW	Buenos Aires	1000
291.2	LOS	Buenos Aires	5000
280	LOU	Mendoza	500
279	F1	Sante Fe	30
275	H5	Cordoba	100
	B2	Buenos Aires	100
270	F2	Rosario	100
	LOJ	Buenos Aires	1000
261.8	LOQ	Buenos Aires	3000
253.3	D3	Buenos Aires	100
252	LOO	Buenos Aires	1000
236	LOL	Buenos Aires	2000
210	LON	Buenos Aires	5000
		AUSTRALIA	
1250	6WF	Perth	1000
484	3AR	Melbourne	320
464	2WA	Sydney	100
442	2FC	Sydney	2000
392	5CL	Adelaide	1000
385	4QG	Brisbane	1000
371	3LO	Melbourne	1000
353	2BL	Sydney	1000
337	4MB	Brisbane	250
326	2BE	Sydney	20
	2GB	Sydney	1500
323	4RN	Rockhampton	100
319	3UZ	Melbourne	20
313	4DN	Adelaide	100
303	3WR	Melbourne	20
297	2VE	Sydney	50
294	4GR	Toowomba	20
288	2HD	Newcastle	20
286	3EO	Mildura	20
280	2KY	Sydney	300
278	4GM	Brisbane	50
275	2MK	Bathurst	250
263	2UW	Northbridge	100
		AUSTRIA	
577		Vienna	
517.2	ORV	Vienna	14000
365.8		Graz	500
294.1		Innsbruck	500
272.7		Klagenfurt	500
254.2		Linz	500
		BELGIUM	
508.5	BAV	Brussels	1500
294.1		Liege	100
275		Ghent	
265.5		Antwerp	100
230		Brussels	
205		Liege	

Wave Length (Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)
		BOLIVIA	
300		La Paz	50
175		La Paz	50
		BRAZIL	
600	SKV	Bahia	50
445	SQAD	Bahia	50
425		Sorocaba	
400	SQAA	Rio de Janeiro	2000
381	RSR	Porto Alegre	80
380	SQAY	Juiz de Fora	200
350	SQAG	Sao Paulo	1000
	SQAK	Ribeirao Preto	
310	SQAB	Rio de Janeiro	500
		Pernambuco	
280	SQAI	Santos	10
260	SQAJ	Rio de Janeiro	500
240	SQAF	Curytiba	8
225.4	SQBO	Sao Paulo	1000
34		Para	
24		Bahia	
		CANARY ISLANDS	
350	EARS	Las Palmas	200
250			
		CHILE	
550	CMAT	Tacna	200
400		Valparaiso	50
360	CMAC	Santiago	1000
345	CMAI	Concepcion	1500
320	CMAD	Santiago	1000
280	CMAE	Santiago	100
245	CMAK	Temuco	100
12		Asuncion	
	CMAO	Antofagasta	
		CHINA	
800	VPS3	Victoria	
480	COTN	Tientsin	500
	XOL	Tientsin	500
445	COHB	Harbin	
425	COMK	Mukden	2000
342	KRC	Shanghai	250
	RSC	Shanghai	250
		Shanghai	250
300	GOW	Victoria	1500
280	CEC	Tientsin	50
		CHOSEN	
357	JODK	Seoul	1000
		CUBA	
376	PWIH	Havana	500
368	6KW	Tuinieu	100
360	5EV	Colon	100
350	2OK	Havana	100
	7SR	Elia	300
347	CMC	Havana	500
334	2AZ	Guanajay	30
326	2RK	Havana	50
325	6LO	Caibarien	250
303	2LC	Havana	30
300	2OH	Havana	15
	8LC	Caney	100
294	2JL	Mariano	7½
284	2MG	Havana	20
280	2CP	Havana	10
	6KP	Sancti Spiritus	20
278	6XJ	Tuinieu	

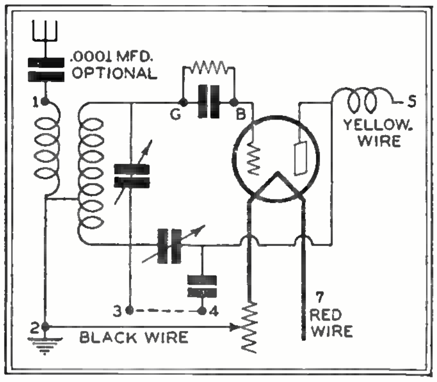
Length Wave (Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)
277	2MA	Mariano	50
275	1AZ	Guanajay	30
	2XX	Havana	10
	6JQ	Cienfuegos	10
274	2SW	Mariano	7½
270	2TW	Havana	30
	5DW	Matanzas	
264	7NM	Nuevitos	20
261	2WX	Havana	150
260	6BY	Cienfuegos	200
257	2OL	Havana	100
252	2JF	Mariano	15
250	2AB	Havana	10
	2BB	Havana	15
	6EV	Caibarien	50
	8KW	Santiago	15
245.5	2JP	Havana	15
240	6KC	Cienfuegos	
235	7BY	Ciego de Avila	20
230	2XA	Havana	200
	7LO	Camaguey	20
228	2UF	Havana	100
226	2FG	Hershey	20
225	7AZ	Camaguey	10
211	2SE	Havana	10
210	6MN	Santa Clara	20
205	2HP	Havana	200
200	6HS	Sagua la Grande	10
	6YR	Camajuani	20
	7FU	Ciego de Avila	15
	8HS	Santiago	30
195	7GT	Camaguey Armanda Vaquer	5
193	7IR	Ciego de Avila	15
192	7HS	Ciego de Avila	15
190	7EV	Camaguey	
	8IR	Santiago	20
180	8KP	Caney	100
150	8BY	Santiago	30
		CZECHOSLOVAKIA	
1870		Kosice	
441.2	OKB	Brunn	2400
384.9	OKP	Prague	5000
300	OKR	Bratislava	500
263	OKK	Kosice	2000
		DENMARK	
1535		Kalundborg	7500
1153.8		Soro	1500
1150		Ryvang	1000
339.8		Copenhagen	1000
		DUTCH EAST INDIES	
310	ANE	Bandoeng	6
220	JFC	Batavia	40
175		Surabaya	
140		Surabaya	500
	ANH	Malabor	
		EGYPT	
225	SRE	Cairo	
		ESTONIA	
1200		Tallinn	100
408		Tallinn	700
		FINLAND	
1525		Lahtis	40000
566		Mikeli	250
500		Helsingfors	1000

Wave Length (Meters)	Call Letters	COUNTRIES AND CITIES	Power (Watts)
400	3NB	Tammerfors (Tampere)	250
318		Lahtis	180
297		Jyvaskyla	200
275		Jacobstad (Pietersarrki)	200
254.2		Jborneborg	100
250		Uleaborg	250
240		Helsingfors	2000
		Viborg	750
		FRANCE	
1780	8AJ	Paris	100
1750	CRF	Paris	3000
480	YN	Lyon	1000
458	FL	Paris	1000
419		Bordeaux	1500
416		Grenoble	150
390		Mont-de-Marsan	300
389.6		Toulouse	2000
350		Paris	500
340.9	5NG	Paris	500
308		Paris	250
300		Marseilles	1000
297	2BD	Agen	500
294		Rennes	1500
290	YR	Lyon	5000
285		Limoges	500
267.3		Lille	500
260	MRD	Toulouse	1000
249		Nimes	
246		Juan-les-Pins	500
246		Nice	
238	FPTT	Paris	200
		Montpelier	200
222.2	8GF	Strasbourg	250
200		Fecamp	
198		Biarritz	250
180		Beziers	500
		GERMANY	
2525		Berlin	5000
1829	KAV	Norddeich	
1648	AFT	Berlin	8000
577		Breiburg im Breisgau	750
566	AB	Berlin	2000
		Augsburg	700
		Hanover	750
536		Munich	4000
475.4		Berlin	4000
468.8		Elberfeld	750
462.2	LA	Langenberg	25000
455.9		Aix-la-Chapelle	750
438.9		Berlin	800
421.3	LP	Frankfort-on-the-Main	4000
391.6	HA	Hamburg	4000
387.1		Dresden	700
	BMN	Bremen	1500
374.1	OKP	Stuttgart	4000
361.9	MR	Leipzg	4005
326.4		Gleiwitz	750
321.2		Breslau	5000
283		Dortmund	750
280.4		Koenigsberg	4000
272.7		Danzig	
265.6	MS	Muenster	1500
263.2	SMXQ	Cologne	4000
250		Kassel	750
		Kiel	750
240		Nuremberg	4000
236.2		Stettin	500
230		Schoerbeek	
219		Flensburg	
204.1		Kaiserlautern	4000
		HAITI	
361.2	HHK	Port-au-Prince	1000
		HAWAII	
270.1	KGU	Honolulu	600
227.1	KGHB	Honolulu	250
		HUNGARY	
1050	MT2	Budapest	400
555.6	MT1	Budapest	2000
	MT3	Budapest	12000
		ICELAND	
333.3		Reykjavik	500
192	G2SH	Akureyri	
		INDIA	
800	VPB	Colombo	
400	2GR	Madras	200
387	2FV	Bombay	100
370.4	7CA	Calcutta	3000
	VUC	Calcutta	
357.1	7BY	Bombay	3000
	VUB	Bombay	
350	2HZ	Rangoon	40
320	2AX	Bombay	50
		IRISH FREE STATE	
400	6CK	Cork	1000
319.1	2RN	Dublin	1500
		ITALY	
449	1RO	Rome	3000
333.3	1NA	Naples	1500
315.8	1MI	Milan	7000
45	1IAX	Rome	
		Genoa	6000
		JAPAN	
390	JOHK	Sandai	1000
385	JOBK	Osaka	1000
380	JOGK	Kumamoto	2000
375	JOAK	Tokyo	1000
361	JOIK	Sapporo	1000
360	JOCK	Nagoya	1000
357	JODK	Keijo	1000
353	JOFK	Hiroshima	10000
		KENYA	
400	7LQ	Nairobi	
35			
		KWANTUNG	
395	JQAK	Dairen	5000
		LATVIA	
526.3	KCX	Riga	2000
		LITHUANIA	
2000		Kaunas	
		Kovno	
		LUXEMBURG	
217.4	LOAA	Luxemburg	250
		MEXICO	
549	CYY	Merida	100
475	CYR	Mazatlan	250
	XFC	Jalapa	
425	CYO	Mexico City	100
400	CYJ	Mexico City	2000
	CYL	Mexico City	500
375	CYH	Mexico City	100
350	CXE	Mexico City	500
337	CYC	Vera Cruz	50
325	CYX	Mexico City	500
	XFF	Chihuahua	
322	CYQ	Tampico	100
312	CYU	Pueblo	100
311	CYS	Monterey	250
310	CZF	Chihuahua	250
300	CYA	Mexico City	500
275	CYB	Mexico City	500
265	CYF	Oaxaca	100
250	CYD	Vera Cruz	500
	XEA	Guadalajara	10
	XES	Ciudad Lerdo	
225	CYM	Torreon	1500
20	CYZ	Tampico	20
	CYH	Monterey	
		MOROCCO	
414		Rabat	
305	CNO	Casablanca	25
		NETHERLANDS	
1875		Scheveningen	2500
1840		Huizen	
1470	PCFF	DeBilt	1250
1060	HDO	Hilversum	1000
340		Huizen	
184	PCLL	Kootwijk	25000
		NETHERLANDS EAST INDIES	
90		Soerabaya	
		NEW ZEALAND	
500	2ZA	Wanganui	
420	1YA	Auckland	500
	2YA	Wellington	5000
400	3AC	Christchurch	500
380	4YA	Dunedin	110
300	4ZB	Otago	
295	2YK	Wellington	60
280	22F	Palmerston	
277.8	4ZM	Dunedin	
275	1ZB	Auckland	
260	2ZM	Gisborne	500
253	1ZQ	Auckland	50
252	4ZL	Dunedin	
250	1YC	Whangerei	15
		NORWAY	
511		Aalesund	
500		Tromso	
447.8		Rjuken	250
434.8		Fredrikstad	750
411		Natodden	700
405		Porsgrund	1000
370.4	OSLO	Oslo	1500
		Bergen	
		Bergen	1500
277.6		Stavanger	1500
243.9		Trondhjem	1000
		PERU	
360	OAX	Lima	1500
		PHILIPPINE ISLANDS	
400	KPM	Iliolo	500
385	KZRQ	Manila	1000
270	KZKZ	Manila	500
260	KZIB	Manila	500
		POLAND	
1111.1	AXO	Warsaw	8000
435		Wilna	
422		Katowice	2000
		Krakow	1300
270.3		Poznan	1500
		PORTO RICO	
322.4	WKAQ	San Juan	500
		PORTUGAL	
305	PIAA	Lisbon	500
		ROUMANIA	
401.6		Bucharest	
		SAN SALVADOR	
482	AQM	San Salvador	500
		SENEGAL	
300		St. Louis	100
		SPAIN	
500	EAJ22	Salamanca	500
462	EAJ13	Barcelona	1000
434.8	EAJ9	Bilbao	1000
	EAJ17	Seville	600
420	EAJ2	Madrid	600
400	EAJ3	Cadiz	1000
375	EAJ7	Madrid	1200
344.8	EAJ1	Barcelona	1000
330	EAJ16	Cartagena	1000
320	EAJ18	Almeria	1000
297	EAJ8	San Sebastian	3000
280.4	EAJ19	Oviedo (Cima)	200
100	EAJ25	Malaga	100
		STRAITS SETTLEMENTS	
330	1SE	Singapore	100
		SWEDEN	
1380	SASG	Motala	30000
1190	SASE	Boden	600
720	SASF	Ostersund	600
555.8		Hamar	
545.6	SASD	Sundsvall	600
500	SMRM	Uppsala	150
	SMUW	Linkoping	200
454.5	SASA	Stockholm	1000
416.1	SASB	Goteborg	600
400	SMXO	Molmbergt	250
335.3	SMZK	Falun	500
297	SMSO	Varberg	300
294.1	SMZP	Uddevalla	500
278.8	SMZQ	Trolhattan	400
275.2	SMVV	Norkoping	250
272.7	SMSL	Hudiksvall	160
260.9	SASC	Malmo	600
252.1	SMTS	Saffle	400
250	SMUC	Eskilstuna	200
238.1	SMTG	Kiruna	400
236.2	SMTI	Orebro	200
230.8	SMYB	Boras	150
229	SMSN	Umea	200
	SMYE	Helsingborg	200
222.2	SMZA	Ormskoeldsvik	200
220.6	SMXG	Karlstad	250
215.8	SMSB	Halmstad	200
204.1	SMXF	Gavle	200
202.7	SMTJ	Kristinehamn	250
201.3	SMZD	Jonkopings	250
196	SMSM	Karlskrona	200
		SWITZERLAND	
1000	HB3	Basel	300
850	HB2	Lausanne	600
760	HBI	Geneva	500
500	HBZ	Zurich	1500
407	HBA	Berne	1500
		TUNISIA	
1850	TUN	Carthage	5000
1450	TUA	Tunis	100
45	TUA	Tunis	100
42.8	8KR	Constantine	
		TURKEY	
1806		Angoria	6000
1200		Osmanieh	6000
		Stamboul	15000
		UNION OF SO. AFRICA	
443.5	JB	Johannesburg	900
398		Durban	1200
372	WAMG	Capetown	1200
323		Pretoria	
32	JB	Johannesburg	900
		UNION OF SOVIET SOCIALIST REPUBLICS (Formerly Russia)	
1700	RA43	Kharkov	4000
1450	RA1	Moscow	40000
	RDW	Moscow	500
1117	RA32	Novorossisk	4000
1100	RA57	Irkutsk	500
1070	RA67	Nalchik	240
1050	RA49	Erivan	1200
1000	RA42	Leningrad	10000
975	RA40	Odessa	1200
950	RA12	Voronezh	240
925	RA39	Gomel	1200
900	RA9	Sevastopol	250
	RA22	Samara	1200
875	RA41	Vologda	1200
870	RA11	Tiflis	4000
860	RA18	Minsk	1200
840	RA13	Nizhni-Novgorod	1800
820	RA14	Rostov-on-Don	4000
800	RA7	Ivanova-Vosnensensk	180
790	RA56	Artemovsk	1200
775	RA45	Kiev	1200
765	RA46	Petrozavodsk	2000
751	RA27	Tashkent	2000
750	RA8	Bogorodsk	700
	RA45	Baku	4000
730	RA77	Stalino	1200
720	RA47	Armavir	200
700	RA26	Astrakhan	1000
690	RA44	Tver	1200
640	RA25	Orenburg	1000
620	RA16	Vel Ustjuk	1200
575	RA34	Koursk	1000
550	RA20	Stavropol	1200
525	RA30	Dniepropetrovsk	1000
513	RA38	Krasnodar	1000
500	RA51	Ulyanovsk	20
480	RA17	Vladivostok	1500
475	RA43	Kharkov	4000
450	RA2	Moscow	500
	RA4	Moscow	300
420	RA32	Saratov	200
350	RA64	Petropavlavsk	45
330	RA68	Smolensk	20
300	RA21	Tomsk	150
150	RA72	Smolensk	800
	RA59	Leningrad	350
		UNITED KINGDOM	
1600	5XX	Daventry	16000
500	2BD	Aberdeen	1500
491.8	6BM	Bournemouth	1500
405.4	5SC	Glasgow	1500
400	5PY	Plymouth	200
384.6	2ZY	Manchester	1500
353	5WA	Cardiff	1500
326.1	5IT	Birmingham	1500
323.2	5GB	Daventry	25000
312.5	5NO	Newcastle	1500
306.1	2BE	Belfast	1500
297	6LV	Liverpool	200
	2LO	London	200
294	2DE	Dundee	200
	5SX	Swansea	200
	6KH	Hull	200
	6ST	Stroke-on-Trent	200
288.5	2EH	Edinburgh	500
277.8	2LS	Leeds	500
275.2	5NG	Nottingham	200
272.7	6FL	Sheffield	200
252.1	2LS	Bradford	200
32.5	2NM	Caterham	
24	5SW	Daventry	
	6SW	Chelmsford	
		URUGUAY	
500	CWOW	Montevideo	
428.4	CWOA	Montevideo	1000
380	CWOS	Montevideo	500
350	CWOR	Montevideo	500
300	CWOF	Montevideo	100
	CWOH	Montevideo	50
294	CWOO	Montevideo	50
280	CWOG	Montevideo	10
272	CWOI	Salta	50
	CWOL	Montevideo	100
265.5	CWOM	Montevideo	20
260	CWOK	Montevideo	50
256.5	CWON	Montevideo	10
250	CWOJ	Salta	200
		VENEZUELA	
375	AYRE	Caracas	1000
		YUGOSLAVIA	
309.2		Zagreb	100

This Laboratory Instrument Has *Many* Uses

BOYS of today may be intrigued by more modern and more expensive playthings; but what father of such youngsters does not recall how he once prized, or longed to possess, that mark of youthful affluence—a "combination" pocket knife?

Memory fails to bring back all of the things that this strange-looking blend of tool box, manicure set, surgical kit, etc., could be made to accomplish. But equal to almost any juvenile task were the large, small and middle-sized blades; the screw driver, chisel and file, *the cork-screw, bottle opener,* nail puller, scratch awl and divers other appliances.



The circuit diagram of the multi-unit when used as a short-wave adapter, connected by means of the cable-plug to the detector socket of a broadcast receiver

Mothers of the time when such treasures flourished would attest to their destructive influence upon pockets of pants or overalls. For it was difficult to make one handle contain all of the tools hinged to it; hence, a lot of projecting points and edges.

And now the boat-building, whistle-making, initial-carving boys of yesterday are the radio owners and experimenters of today, with the urge as strong as ever to make or make over things. Chiefly different is the sort of combination instrument they need to make new receiving sets, or to make old ones newer and better.

To be sure, it is slightly larger than pocket size, and its contents are coils, condensers, wires and things, rather than tools. But just as capable of delighting the boy of today and yesterday is the radio device described here, with its almost unlimited number of circuit variations.

A Many-Purpose Radio Device

To mention only a few, this unit constitutes at will a one-tube set for either broadcast or short waves: a short-wave adapter or converter to operate with a.c. or d.c. receivers; a radio-frequency oscillator, modulated or unmodulated; a pre-amplifier or "booster"; a wave trap, wavemeter, crystal receiver—and all within the compass of 5 x 7 x 3 inches.

By George W. Walker

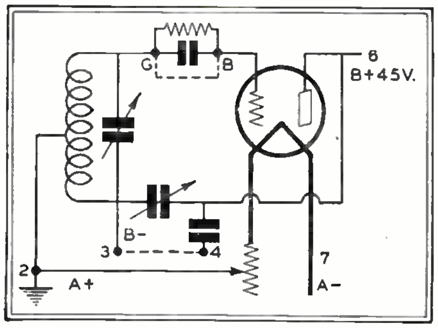
MR. WALKER, of Victoreen fame, is the designer of the very versatile unit which is described here. Undoubtedly, to the experienced experimenter many other uses besides the few which are explained here will suggest themselves.

The serviceman, the laboratory research worker and the dyed-in-the-wool set builder will find in this veritable Jack of All Trades just the device which will make his work simpler and more accurate.

Although termed "the unit of a dozen uses at the cost of one," it is difficult to realize how much has been crammed into this small device. Proof is found in accompanying photographs and diagrams, and this description of some applications.

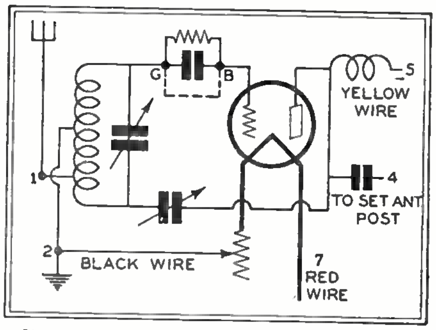
It will be seen that flexibility is achieved by making almost every part of the circuit readily accessible. Condensers, choke, etc., can be included or shorted out, tuning capacity increased, wavelength range altered, regeneration added or eliminated, merely by changing connections at the binding posts, or by shifting coils.

In this era of short-wave transmissions in both voice and code, attention naturally is attracted to such a unit by its ability to tune in stations below the range of broadcast receivers. This it accomplishes either alone or when plugged into the detector socket of a set, to take advantage of the audio amplifier. Such use is illustrated in the diagram Fig. 1. Power for the unit is drawn from the receiver. One of the coils furnished with the unit will cover a band of about 15 to 95 meters. This is the popular short-wave band for broadcast and amateur stations. The other coil furnished covers the broadcast band of 200 to 550 meters. While a coil to cover the 100 to 200 meter band is available, it is not included as part of the unit.



If you need a modulated radio-frequency oscillator for testing the tuning range of a receiver, or condenser, coil combination then the unit is connected according to the above circuit

Types of tubes that will perform efficiently include the 226, 201A, 199, 112A, 222 and 224 screen-grids, and the high mu 240. Due to the extreme flexibility of the multi-unit it may be used with either a.c. or d.c. receivers.



For an unmodulated radio-frequency oscillator the multi-unit is connected as shown here

Perhaps even more fascinating than picking up short-wave programs and code messages is another use of the multi-unit. Assume that the receiver with which it has been working doesn't seem too efficient. If it is of the single-dial variety, the trouble may be that the radio-frequency stages are out of step, or in more technical terms, off resonance.

As Oscillator and Set-Tester

What can the unit do about this? Why, a lot, if it is connected as a radio-frequency oscillator. Putting this in another way, it is made into a miniature broadcasting station. As such it sends out a modulated or unmodulated wave of controllable frequency to which a receiving set will respond, just as it does to programs in the air. The circuit used is shown in the diagram, Fig. 2.

With the dial of the oscillator adjusted to about midway of its scale, tune the receiver under test until a squeal or whistle is heard. This indicates that the oscillator is functioning.

Now attach one side of the .0001 mfd. fixed condenser furnished with the unit to terminal "G," along with the grid leak and condenser. Disconnect the antenna from the set, and run a wire with a spring clip to the free end of the condenser. Then attach the clip to the antenna post of the set under test.

The tone of the oscillator will then be audible in the loud speaker. When it has been peaked carefully by tuning the receiver dial, make note of the scale reading. Then shift the clip from antenna post to the plate terminal of the first radio-frequency tube socket, retune the receiver, and again note the dial setting.

Repeating this process with each radio frequency stage, that one that is off resonance can quickly be detected, and correction made so that, regardless of the position of the clip, settings of the receiver dial are uniform.

Reversing the procedure just outlined, the oscillator can be calibrated by tuning the set to a known broadcasting station, then putting the oscillator in resonance with the receiver, and noting the oscillator dial setting.

Suppose that the station is WLW, Cincinnati, which broadcasts on 700 kilocycles, and that the oscillator dial reads 60. Then this setting will always correspond to 700 kilocycles, and stations in that channel will be picked up by tuning a receiver to the oscillator when its dial is at 60.

After several stations at various points in the broadcast band have been logged on the multi-unit when it is used as an oscillator, it will function as a wavemeter. And if a graph be prepared with its curve running through the plotted positions of these stations, the places at which others should come in can be determined quite accurately.

It might happen, for example, that a new receiver was being tried out for DX, and that its dial was not sufficiently accurate to make sure of KFI's presence or absence. With the oscillator set at 640 kilocycles and the receiver tuned to it, Los Angeles would be heard if within range, after the oscillator had been shut off.

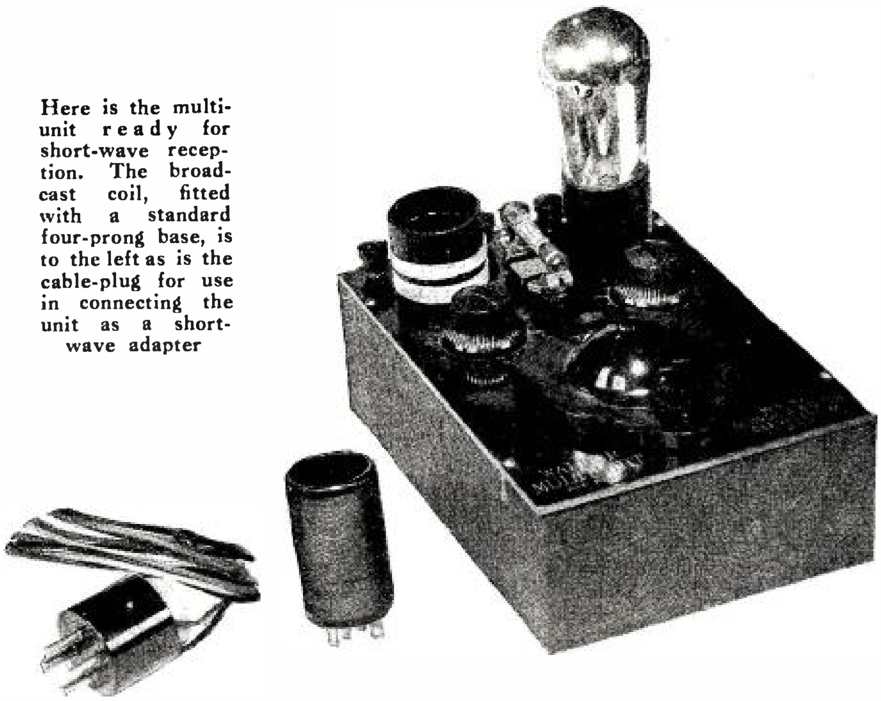
For portability and convenience, the unit can be powered as a radio-frequency oscillator by a 4½ volt "C" battery lighting the filament of a 199 tube, and a 22 or 45-volt "B" battery for plate supply.

Such are only two of the many uses for the radio-frequency oscillator into which this unit can be so easily converted.

Short-circuiting the grid leak and condenser, as shown by a dotted line in the diagram, Fig. 3, gives an unmodulated note for special purposes. Another range control is the fixed condenser that can be cut into or out of the tuning circuit.

The result of using the multi-unit as a pre-amplifier or booster with a broadcast set is, naturally, increased range, selectivity and volume. The device then serves as an additional stage of radio-frequency, with or without regeneration.

The operation is the very simple one of plugging into the first radio-frequency



Here is the multi-unit ready for short-wave reception. The broadcast coil, fitted with a standard four-prong base, is to the left as is the cable-plug for use in connecting the unit as a short-wave adapter

A Handy R. F. Amplifier or Short-Wave Adapter

socket of the receiver, then tuning the unit dial with those of the set.

Of particular interest is such employment of the multi-unit by owners of sets of the older vintage, with good amplifiers and speakers, but perhaps only a stage or two of radio-frequency instead of the three or four that are common now.

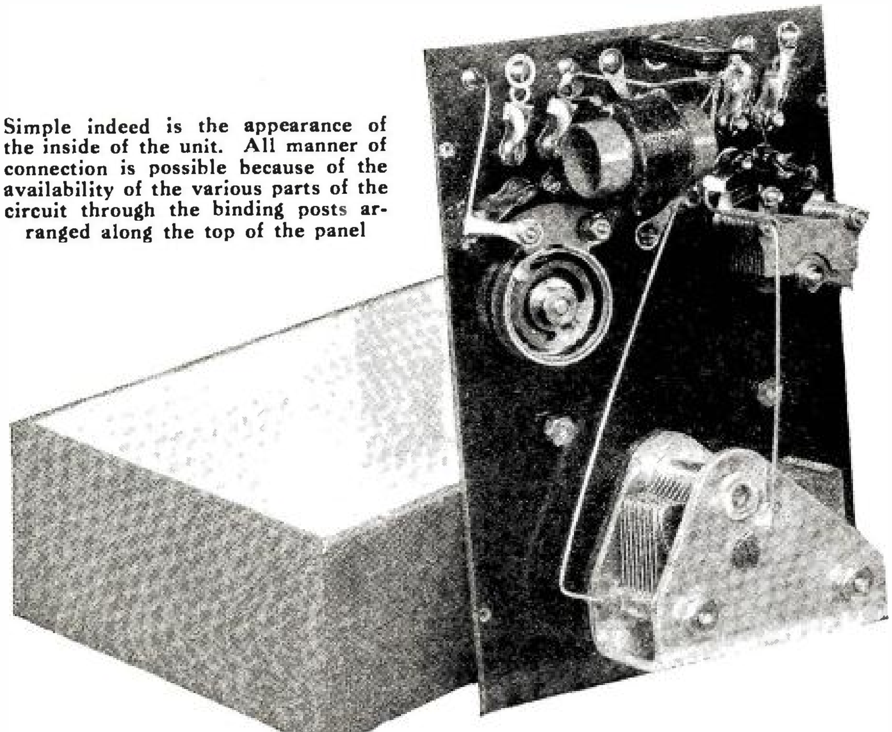
The logical thing, then, is to add a stage, and since putting it inside the cabinet would be difficult if not impossible, a small external unit that is easy to connect and tune is the thing. And the multi-unit makes use not only of standard radio-frequency tubes, but the more efficient screen-grid types as well. To facilitate the extra connection, a tube cap clip is provided.

Balancing to prevent oscillation is accomplished by means of a midget condenser. And the same instrument provides any degree of regeneration up to the "spilling" point. Thus the pre-amplifier can be kept "hot" at all frequencies.

Perhaps the owner of a broadcast set is troubled by broad tuning that permits locals to monopolize too much of his dial. With a multi-unit he has two remedies; either to use it as an additional radio-frequency stage, with a gain in selectivity, or to connect it as a wave trap in various ways. Tune the trap to the unwanted station, the set to the wanted one, and there you are.

Directions for using the unit cannot be given in detail here. But to illustrate the simplicity of connecting it in different ways, here are instructions for employing it as a short-wave adapter or converter with a direct current receiver.

"Connect red wire of adapter plug to binding post No. 7, black to No. 2, yellow to No. 6. Remove detector tube from receiver and insert in socket "T" of unit. Insert plug in detector socket of set. Remove antenna from set and connect to post No. 1. Fasten ground wire to post No. 2. All tuning is done with the dial of multi-unit.



Simple indeed is the appearance of the inside of the unit. All manner of connection is possible because of the availability of the various parts of the circuit through the binding posts arranged along the top of the panel

The Junior RADIO Guild

What Is an Audio-Frequency Amplifier?

Lesson III

IN Lesson No. 2 was described the action of detection or rectification performed by the detector tube and its associated circuits. It will be remembered from this previous lesson that the character of the incoming signal, composed of radio frequency alternations or oscillations, was changed, through the action of the detector tube so that a variation in the strength of the current in the plate circuit of that tube was produced. It was this varying current, which, passing through the windings of the small electro-magnets in the ear-phones, produced the sounds which we recognized as speech or music.

As described, this varying current was not of an alternating character, but was of a direct, pulsating character. That is, the current flowed constantly in one direction, the sound being produced through the medium of the 'phones by virtue of the changing, varying strength of this current. It is important to remember this, because it has a direct bearing on the following description of the theory of operation of an audio-frequency amplifier.

HEREWITH is presented the third Junior Radio Guild lesson. It explains in simple, understandable terms how an audio amplifier works and describes in detail the construction of a two-stage audio-frequency amplifier which is to be added to the single-tube tuner unit described in last month's lesson.

In this first series, consisting of five lessons, the various diagrams and sketches are consecutively numbered. Thus, the first figure in this, the third lesson, is Fig. 10.

To gain a comprehensive idea of the general construction of the five-tube receiver, part by part, it is well to compare the present lesson with its various sketches and photographs with those which have already been printed.

Magnetism and Electro-Magnetic Induction

There are certain metals which possess the property of attracting to them scraps of iron or steel and are known as artificial magnets. A substance naturally possessing this property and found in the earth is known as lodestone, and if a bar of hard steel is rubbed with the lodestone the steel will become magnetized and is then an artificial magnet. Simple experiments will prove that the strongest force of attraction exists at the ends of the magnetized bar, and are known as the poles.

This stronger force which exists at the poles can be very well illustrated by placing a piece of paper over the bar magnet and then sprinkling iron filings on the paper. The filings will be seen to assume a definite pattern on the paper, more filings accumulating at the ends than at the middle. This pattern shows the general direction of the magnetic force and indicates that the space about the poles of a magnet is in a state of stress or strain. The space occupied by these magnetic lines of force is termed the magnetic field, and the total lines of force found in this field are called the magnetic flux. See Fig. 10.

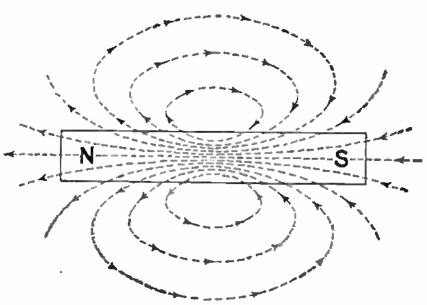


FIG. 10

In a steel bar which has been magnetized, the lines of force, if they could be seen, would shape themselves into the pattern shown above. The arrowheads indicate the direction of flow of these lines of force

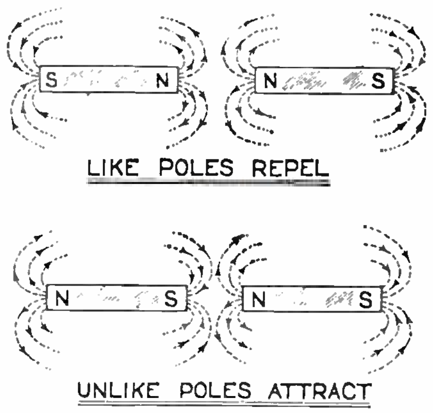


FIG. 11

If two magnetized bars are placed with similar ends together, as shown at the top, there will be a repelling action; if unlike poles are placed together they will attract each other (bottom)

Bars of steel so magnetized and left to swing freely or pivoted will point to the north magnetic pole, like the needle of a compass. The end which does point to the north is known as the north pole of the magnet, while the opposite end is the south pole.

Experiment will prove that if two magnetized bars of steel are brought close together, with the north pole of one near the north pole of the other, there will be produced a distinct repulsion. This is also true if both south poles are brought together. On the other hand, if a north and a south pole are brought near each other, there will be noticed a distinct attraction. This phenomenon gives rise to the observation that like poles repel, while unlike poles attract. See Fig. 11.

Now if we wind a coil of wire and attach to the two coil terminals some indicating device, such as a galvanometer or other sensitive meter, and then thrust the bar magnet within the coil, a movement of the needle on the indicating device will be noted. This movement or deflection is only momentary, the needle coming to its former zero position when the bar magnet is held stationary within the coil. When, however, the bar is withdrawn from the coil, another similar deflection of the needle is noted. What has happened is that the magnetic lines of force, or the flux of the bar magnet, in cutting across the turns of the coil, induced in the coil a current which caused the meter to indicate it.

If over the bar magnet is wound a coil of wire, with its ends connected to a battery or other source of voltage supply, then the whole is known as an electro-magnet. Now, if this electro-magnet is thrust within the first coil, a greater deflection of the indicating meter will be reproduced than when only the plain bar magnet was used. See Fig. 12.

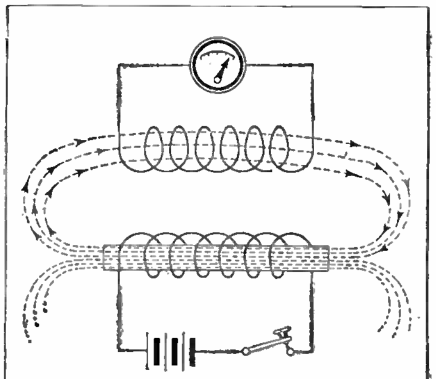


FIG. 12

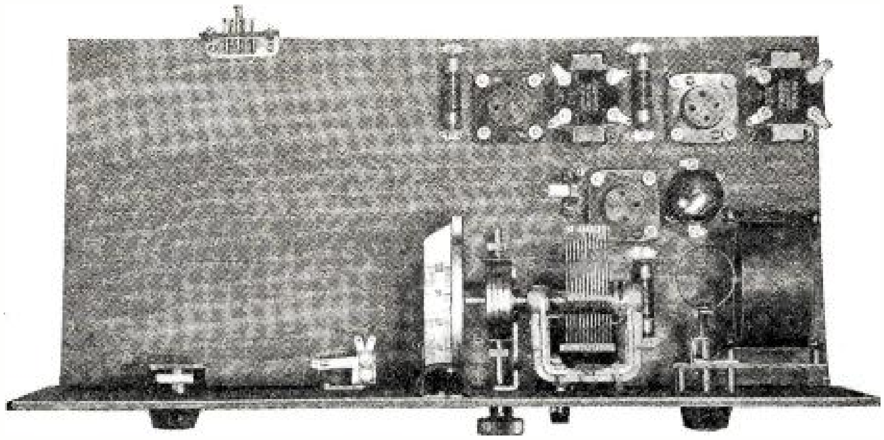
When the circuit of an electromagnet is closed momentarily a current will be induced into another coil located in close proximity to it

However, as before, the deflection will be caused only when the electro-magnet is actually being moved through the first coil, but not when it is at rest. From this it will be observed that a current indication is obtained only when the electro-magnet is moving through the coil, thereby inducing in it a current. When the electro-magnetic field surrounding the electro-magnet is stationary, then no current is induced in the second coil, but when the electro-magnetic field is in motion the magnetic lines of force or flux of the electro-magnet are acting upon the second coil, thus inducing therein a current.

Now the flux of the electro-magnet can be made to move in several ways. Either the electro-magnet itself can be made to move or rotate so that the lines of force which are set up cut through or cross the turns in the indicating coil, or the connection to the battery supplying voltage to the winding about the electro-magnet can be periodically opened and closed, thus causing the flux or magnetic field to rise and collapse about the electro-magnet.

This entire action can be amplified or more closely observed if a core be added to the existing apparatus. The core would then take the place of the bar magnet, the first coil being wound on one of the legs of the core, with the second or indicating coil being wound on another. This entire collection of apparatus would then resemble a transformer, consisting of a primary coil (the one with the battery attached to its terminals), a secondary (the one with the indicating meter attached to its terminals) and a core.

As has been explained, if the connection in the battery or primary circuit be closed, then a momentary reading or deflection on the indicating meter will be noted only for that fraction of a second which is taken by the lines of force set up by the primary circuit to completely thread their way through the secondary coil. During the time the connection is closed there will be no deflection of the indicating needle because the flux or lines of force are stationary. However, when the connection is opened, a deflection similar to the first will be noted.



Here is the JRG receiver with the two-stage audio channel added to the tuner, described last month

Below is given the complete schematic circuit diagram of the two-stage audio-frequency amplifier described in these pages

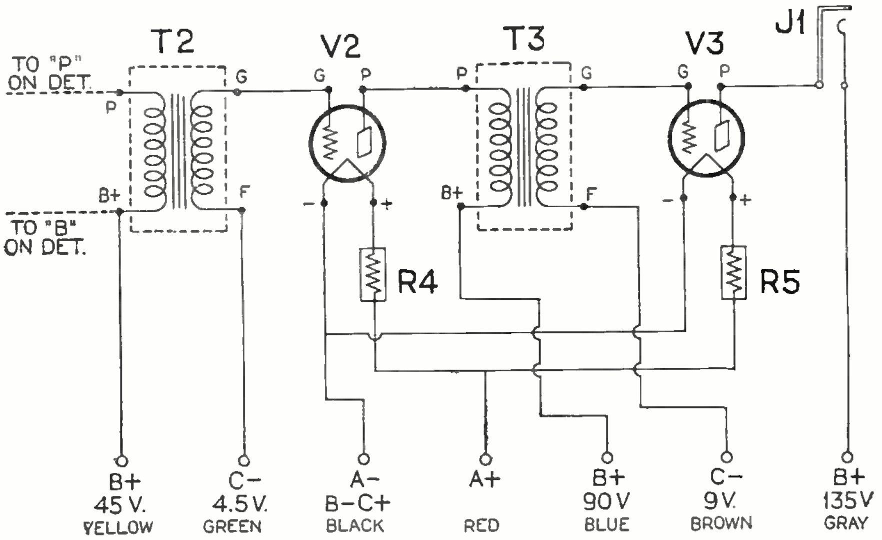


FIG.13

The Audio-Frequency Transformer

Now, if in place of the constant current flowing through the primary from the battery, a current varying in strength is applied to the primary circuit, then the electro-magnetic field set up by the primary will vary in accordance with the variations in the strength of the current flowing through the primary, thus causing a varying movement of the flux which is threading its way through the secondary.

Previously it was observed that when the connection to the battery circuit was closed, a deflection in one direction on the meter was noted, while when the connection was opened, the deflection was in the opposite direction. This was caused by the rising of the flux when the connection was closed, causing a deflection in one direction while when the connection was opened, thus allowing the flux or magnetic field to collapse, the current induced in the secondary was in the opposite direction, thus causing an opposite deflection. This rise and fall of current is quite important to remember, because it is necessary to keep it in mind when observing what is taking place when, instead of the make and break of the current by opening and closing the battery connection, a varying direct current is applied to the primary. What happens in this instance is that the varying flux set up by the primary circuit induces in the secondary circuit an alternating current of greater voltage than that originally found in the primary circuit. This step-up is caused by the fact that the secondary coil has many more turns than the primary; in fact, this step-up is a function of the ratio of proportion which exists between the primary and secondary. If the latter has five times as many turns as the former the ratio is said to be 5 to 1.

Observe now that after applying an alternating radio frequency signal to the grid of the detector tube and then rectifying or detecting it so that we could employ the audio frequency variations to actuate a pair of phones, we are now applying this pulsating direct current audio frequency signal to the primary of an audio transformer and obtaining at its secondary terminals an alternating current signal, enlarged by virtue of the amplifying characteristics of the step-up transformer. This alternating current signal cannot be compared to that originally absorbed by the antenna because the antenna signal was of a radio frequency or inaudible nature, while this which we now have is of an audio frequency or audible nature.

As a simple comparison, the action of the transformer in performing the task assigned to it can very well be likened to the cutting of a loaf of bread. You can have your bread, and even go so far as to place the knife upon it, but, unless you give motion to the knife, moving it backward and forward, there will be no cutting of the bread. It is the same with a transformer. You can have the two windings, the core, and the current in the primary circuit, but, unless this current is varying in nature to cause a setting up and collapsing of the magnetic field, there will be no current induced in the secondary circuit. When the current in the primary remains constant, then a stationary flux or magnetic field is set up, but no current is induced in the secondary.

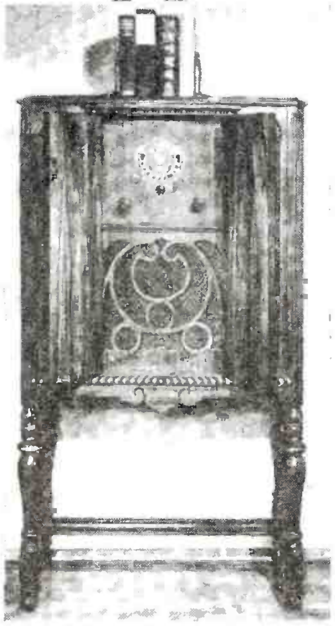
(*Continued on page* 354)

1930 Styles and Specifications for Receivers and Speakers

ON the following pages are grouped representative illustrations of new model receivers, chassis, cabinets and speakers; showing the variety and trends in design provided by manufacturers.

IN tabular form, also, are given the essential facts as to number and types of tubes for as many receivers as this information was available, at the time of going to press; as well as the characteristics of leading makes of loud speakers.

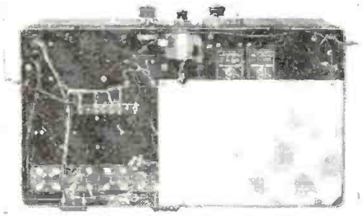
1930 Styles *and* Specifications *for* Receivers *and* Speakers



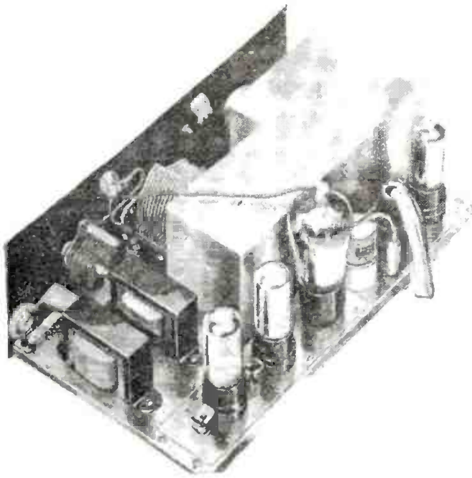
Above, Graybar Electric Company: at the right, Columbia Phonograph Company; below, Trav-ler Manufacturing Company

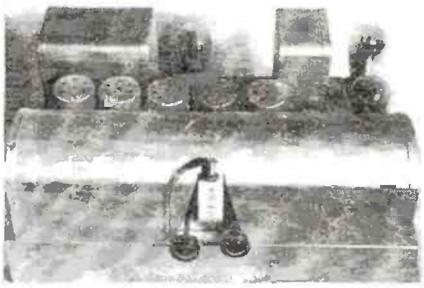
Above, Pierson Cabinet

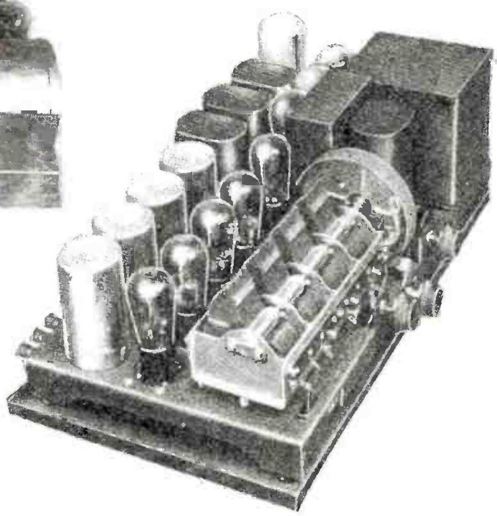
Above, Stromberg-Carlson Tel. Mfg. Co. console; below, Lafayette Duo-Symphonic

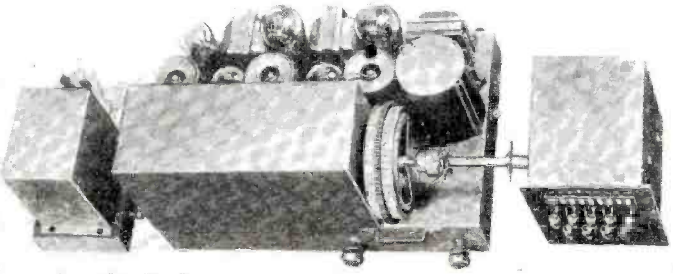


Center of page, top view of Lafayette Duo-Symphonic; immediately below, Balkeit chassis, Model C (Fansteel Products, Inc.); lower left corner, Zenith chassis with push-button tuning; directly below, Bremer-Tully chassis





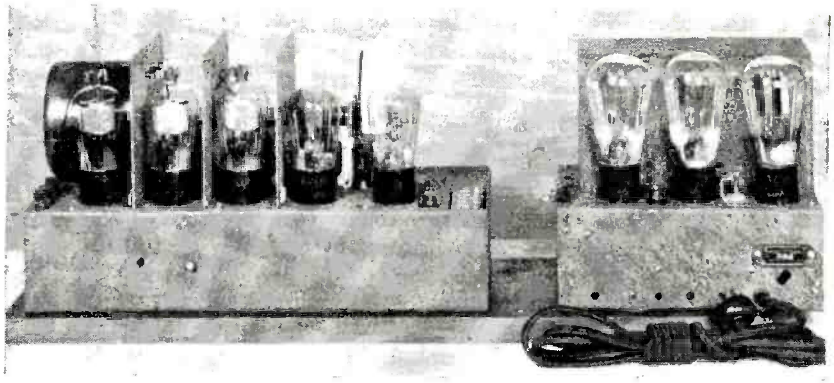




Receiver Characteristics

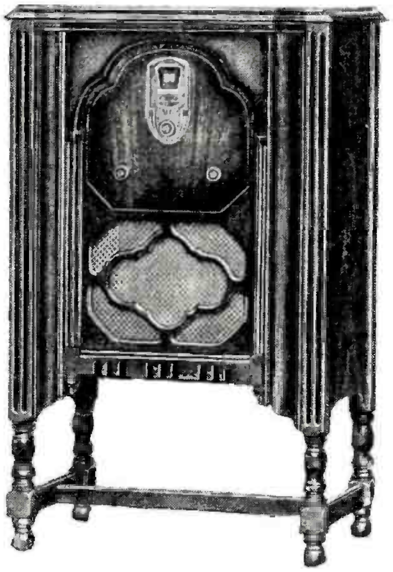
Manufacturer	Model Number	NUMBER AND TYPE OF TUBES R. F.	DET.	1st A. F.	2nd A. F.
A-C Dayton *A-C Dayton Co.*	98 9960 9970 9990 9100 9980	Five '27	'27	Two '45	
Acme *Acme Elec. & Mfg. Co.*	88 77 Console A-C-7	Three '27 " "	'27 " "	'27 " "	Two '45 '45 Two '45 '71A
Amrad *American Radio and Research Corp.*		Three '24	'27	'27	Two '45
Apex *U. S. Radio & Television Corp.*	No. 36 No. 50 No. 55 No. 89 No. 60 No. 70 Console	Three '26 " " Four '26 Two '24 Three '24 "	'27 " " " " " "	'26 " " " '27 " "	'71 " " Two '71A Two '45 " "
Atwater Kent *Atwater Kent Mfg. Co.*	55 Screen Grid, Table No. 55 Chassis Console	Two Screen Grid	'27	'27	Two '45 Push-Pull
Balkeit *Fansteel Products, Inc.*	Console Chassis	Four '27 Three '27	'27 "	'27 "	Two '45 "
Bosch *American Bosch Magneto Corp.*	48 Table Console De Luxe	Three '24	'27	Two '45	
Brandes *The Brandes Corporation*	B-10 B-11 B-12	Three '27 " "	'27 " "	'27 " "	'71A Two '45 "
Bremer Tully *Chicago*	81 82 80	Three '27 " Three '01A	'27 " '00	'27 " '01	Two '45 " Two '71
Brunswick	No. 14 No. 21 No. 31	Three '27	'27	'27	Two '45
Buckingham *Buckingham Radio Corp.*	No. 6950 No. 2 No. 1 No. 3	Four '26	'27	'26	Two '71A
	Phono-Radio Phonograph	None	None	None	None
Bush and Lane *Bush & Lane Piano Co.*	No. 20 No. 21 No. 30 No. 32 No. 34 No. 40 No. 60 No. 50 No. 70 No. 90 Phono Radio	Three '27	'27	'27	Two '45
Colonial *Colonial Radio Corp.*		Three '27	'24	'27	Two '45
Continental "Star Raider"	R-20 R-30 R-P-40	Six Cardon Heaters	Cardon Heater	Two '50	
Crosley *Crosley Radio Corp.*	32 22 42	Four '26	'27	Two '71	
	82 31 21 41	Five '27 Four '26 Three '22 Four '26	" " '01A '27	Two '45 '71A '71 '71A	
Day Fan	68 72 69 66	Four '26	'27	'26	Two '45
	73 Console	Four '01A "	'01A "	'01A "	"12" "
Earl *Chas. Freshman Co., Inc.*	No. 22 No. 32 No. 31 No. 41	Four '26 Four '27 " Five '27	'27 " " "	'27 " " "	Two '71A Two '45 " "
Edison *Thos. A. Edison, Inc.*	"R-4" "R-5" "C-4"	Three '27	'27	'27	Two '45
Erla *Eletrical Research Laboratories*	R2 Screen Grid	Three '26 Two '24	'27 "	'26 "	Two '71A Two '45
Emerson *Emerson Radio & Phono. Corp.*	"C" Console "D" Console	Three '26	'27	'26	Two '45

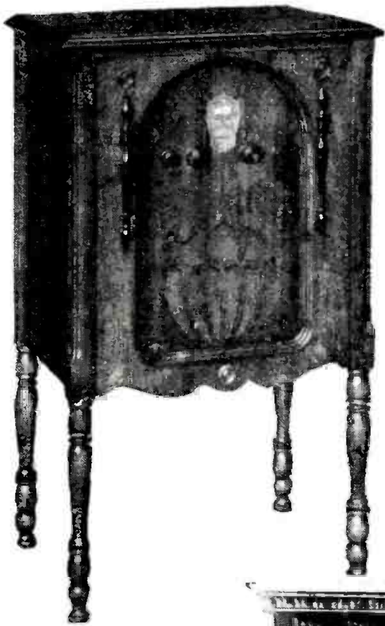
Manufacturer	Model Number	NUMBER AND TYPE OF TUBES R.F	DET.	1st A. F.	2nd A. F.
Eveready *National Carbon Co., Inc.*	No. 31 No. 32 No. 33 No. 34	Three '27	'27	'27	Two '71 Push-Pull
New "40" Series with Two '45 Push-Pull	42 43 44	Three '27	'27	'27	Two '45 Push-Pull
New "50" Series Screen Grid		Three '24	'27	'27	Two '45 Push-Pull
Federal *Federal Radio Corporation*	L-36 L-46 M-41 M-46	Three '24 " Three '27 "	'27 " " "	'27 " " "	Two '45 " " "
Fada *F. A. D. Andrea, Inc.*	20 25 35 75 77	Three '27 Two '24 " Three '24 "	'27 " " " "	'27 " " " "	Two '71A Two '45 " Two '10 "
"Freed" *Freed-Eisemann*	55	Four '26	'26	"	Two '71
	78 79 95	Four '27	'27	'27	Two '45
Gilfillan Bros., Inc.	100	Four '27	'24	'27 Resistance Coupled	'45 Resonated Primary
Graybar *Graybar Electric Co.*	311 310 320 330 340	Three '26	'27	'27	'71
Grebe Syncro-phase *A. H. Grebe & Co., Inc.*	270 285 450	Three '24	'27	Two '45 Push-Pull	
Gulbransen *Gulbransen Piano Co.*	291 292 295	Four '26	'24	'26	Two '45
High Frequency Laboratories Chicago	Chassis	Feeds either a.c. or d.c. dynamic. One dial, one spot tuning, 10 tubes, Superheterodyne Four screen grid tubes, 4 '27 tubes, 2 '45 tubes Uses five tuned filters, each individually adjustable.			
Howard *Radio Co. Chicago*		Four '26	'27	Two '45	
Kennedy *Colin B. Kennedy, Inc.*	310 210	Three '27	'27	'27	Two '45
Kolster *Kolster Radio Corp.*	45 44 43	Three '24 " "	'27 " "	'27 " "	Two '27 Two '50 in 3rd Stage Two '45
Seven Seas *C. R. Leutz Inc.*	Seven Seas	Three Screen Grid	'27	'27	Two '10
Kellogg *Kellogg Switchboard & Supply Co.*	523 524 Phono Radio	Three '24 " "	'27 " "	'27 " "	Two '45 Two '50 "
"National"	Chassis	Four '27	'27	'27	Two '45
Lyric *All-American Mohawk Corp.*	93 SG1 95	Five '27 Three '24 Five '27	'27 " "	Two '27 Push-Pull "	Two '45 Push-Pull "
Majestic *Grigsby Grunow Co.*	Console	Four '27	'27	Two '45	
McMillan *Radio Corp.*	Console	Four '26	'27	'26	Two '45
Minerva *Radio Co.*	Console	Three '27	'27	'27	Two '45
Norden Hauck, Inc. *Philadelphia*		Five '24	'27	'27	Two '45
Philco *Philadelphia Storage Battery Co.*	65 Low Boy Hi Boy	Two Screen Grid	'27	Two '45 Push-Pull	
	De Luxe Hi Boy Lo Boy 87 Hi Boy 87 De Luxe Hi Boy 87	" Three '26 " "	" " " "	'26 " " "	Two '45 Push-Pull " "

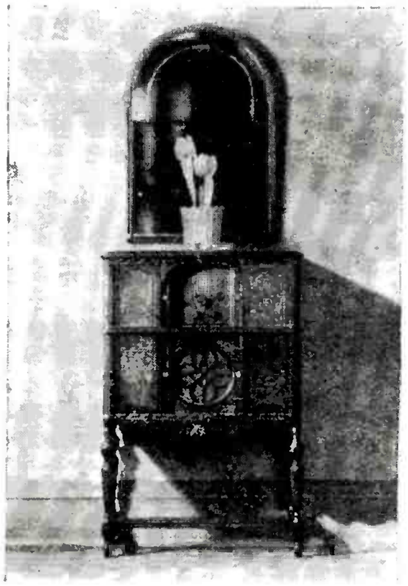


Above, Eveready chassis (National Carbon Company); at the left, the Lyric Radio (All-American-Mohawk Corporation)

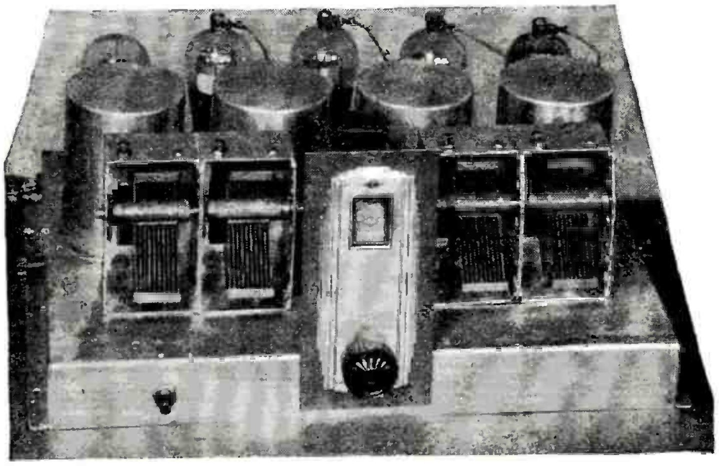
Below, the new Majestic Radio (Grigsby-Grunow Company)



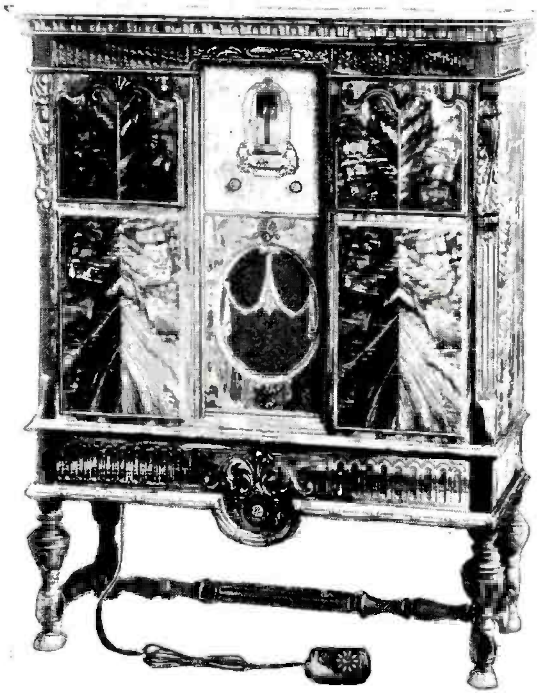




Above, Roemer Radio (Rudolf Roemer Furniture Company); at the left, a Bosch console radio (American Bosch Magneto Corporation)



The MB-29 (The National Company)



New Zenith model with remote-control tuning

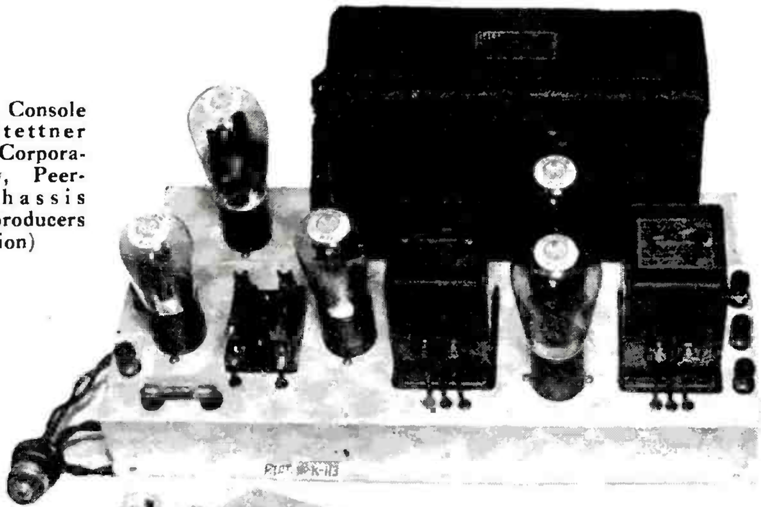
Receiver Characteristics

Manufacturer	Model Number	NUMBER AND TYPE OF TUBES R. F.	Det.	1st A. F.	2nd A. F.
Premier *Premier Elec. Co. Chicago*	"2930-7-M" "2930-7-D" R-53 R-57 R-55 R-54 R-47	Three '27	'27	'27	Two '71
Pierce Airo *New York*	45 46	Three '26	'27	'27	Two '45
Radio Products Laboratory **"RPL"**	4AC 3AC Phono-Radio	Three '26	'27	'26	'26
Pierson *The Pierson Co., Rockford, Illinois*	No. 71	Three '27	'27	'27	Push-Pull '71
Radiola *Radio Corp. of America* **"Radio Victor"**	44 46	Two '24	'24	'24	'45
Silver *Silver Marshall, Inc.*	60 95 30	Three '24	'24	'27	Two '45
Shamrock *Shamrock Mfg. Co.*	Console	Two '27 One '24	'24	'27	Two '45
Sentinel Mfg. Co.	555	Four '26	'27	'26	Two '45
	444	Two '24	"	"	"
	440	"	"	"	"
	550	Four '26	"	"	"
Sonora *Sonora Phonograph Co.*	34	Three '24	Power '27	Two '45	
	No. 30	Three 15-volt Sonora Tubes	"	'27	Two '45
	No. 32	"	"	"	"
	No. 40	"	"	"	"
	No. 36	Four 15-volt Sonora Tubes	"	"	Two '50
	No. 44	"	"	"	"
Sparton *Sparks-Withington Co.*	931	Five 484 Cardon	484 Cardon	Two 182-B Cardon	
	301	"	"	Two 250 Cardon	
	110	"	"	Two '26 Push-Pull	Two 250 Push-Pull
Steinite *Steinite Mfg. Co.*	No. 261	Three '26	'27	'26	'71A
	No. 40	"	"	"	Two '71A Push-Pull
	No. 45	"	"	'27	"
	Phono-Radio	"	"	"	"
Sterling *Sterling Mfg. Co.*	A-2-60	One '24 Two '27	'27	'27	Two '45
	B-2-60	Three '24	"	"	"
Simplex *Simplex Radio Co. Sandusky, Ohio*	Louis XV5	Four '27	'27	'27	Two '45
Shelby *Shelby Mfg. Co. Trenton, N. J.*	52 H-42 H-32	Three '27	'27	'27	Two '45
Stromberg-Carlson *Stromberg-Carlson Tel. Mfg. Co.*	641 642	Three Screen Grid	'27	'45	
Stewart-Warner *Stewart-Warner Corp.*	90 No. 35 No. 58	Three '27	'27	'27	Two '45
Temple *Temple, Inc.*	8-60 8-80 Phono-Radio	Four '27	'27	'27	Two '45
"Temple" *Screen Grid Radio*	8-61 8-81 8-91 Radio-Phono	Two '24	'27	'27	Two '45
"Peerless" *United Reproducers Corp., Peerless Division*	21 22 23 24	Three '24	'27	'27	Two '45
"Courier" *United Reproducers Corp. Arborphone Div.*	65 651 652 653	Three '24	'27	Resis. Coup. '27	Two '45
"Victoreen" *Victoreen Radio Co. Cleveland, Ohio*	Console	(One tuned r.f. '27, 1 oscillator '27, first detector '27, 3 i.f. '27, second detector '27, first audio '27, second audio '50, two voltage reg. tubes, two '81 rectifiers, one '01A tube, "C" rectifier. Superheterodyne.)			
Zenith *Zenith Radio Corp.*	42	Three '27	'24	'27	'10
	41	Four '27	"	"	'71A

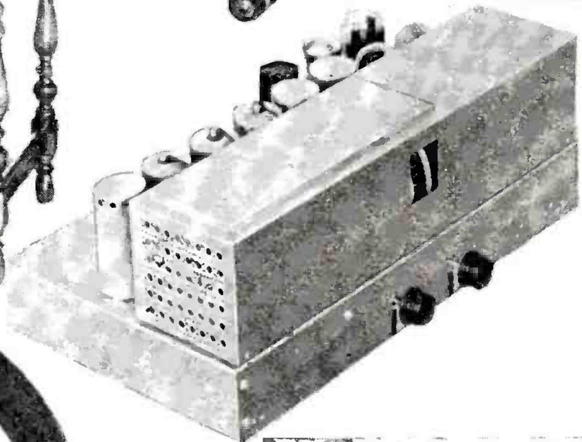
Loud Speaker Characteristics

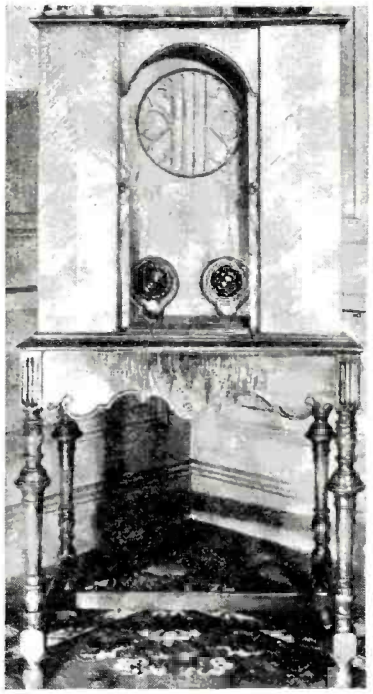
Manufacturer	Model	Type	Size of Cone	Type of Rectifier
Air-Chrome	G	Magnetic	24x26	None
	M	"	18x23	"
	Theatre	"	24x24	"
	Manufacturer's	"	12"	"
Atwater Kent *Atwater Kent Mfg. Co.*	F-4	Dynamic		250 Volts Through Power Pack on Chassis.
Best *Best Mfg. Co.*	"Theatre Dynamic"	Dynamic	"Oversize"	Two '81 Tubes
Crosley	"Dynacoil" Table	Dynamic	7"	
Eveready *National Carbon Co., Inc.*	No. 6	Dynamic	7"	'80
Fada *F. A. D. Andrea, Inc.*	No. 15	Dynamic	7"	Dry Disc
	14	"	8½"	"
	4	Magnetic	7"	
	6	Dynamic		"
Farrand *Farrand Mfg. Corp.*	Chassis	"Inductor Dynamic"	7"	None
	"	"	10"	"
	Cabinet	"	7"	"
		Regular		
Farrand *Farrand Mfg. Corp.*	Chassis	Dynamic	7"	Dry Disc
	"	"	10"	"
	"	"	"	'80
	"	"	7"	D.C. Field
	"	"	10"	"
	Small Baffle	Magnetic	7"	
	Box Chassis	"	"	
	Clock Cabinet	"	"	
	Gothic Cabinet	"	"	
Graybar *Graybar Electric Co.*	Table Model	Magnetic	7"	None
	Console Model 33	Dynamic	"	
Jensen *Jensen Radio Mfg. Co.*	Concert		10"	Tube
	D7 A.C.	Dynamic	"	High Res. Field
	D7 D.C.	"	"	220 V. D.C.
	D7 D.C.	"	"	6 V. D.C.
	D7 D.C.	"		
	Imperial	"	"	Tube
	"	"	"	High Res. Field
	"	"	12"	Tube
	"	"	"	High Res. Field
	Auditorium	"	"	Tube
	"	"	"	High Res. Field
	"	"	"	110 V. D.C.

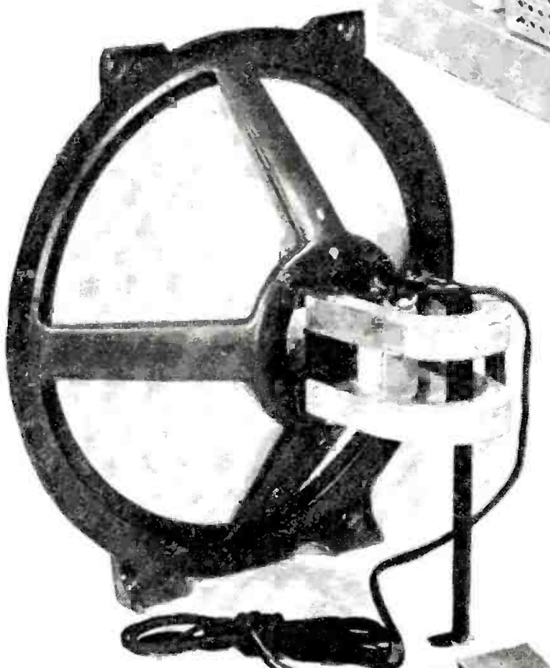
At the left, Console cabinet (Stettner Phonograph Corporation); below, Peerless radio chassis (United Reproducers Corporation)

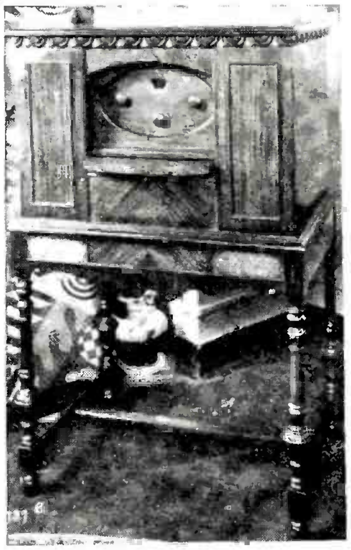


Above, Pilot power amplifier No. K113



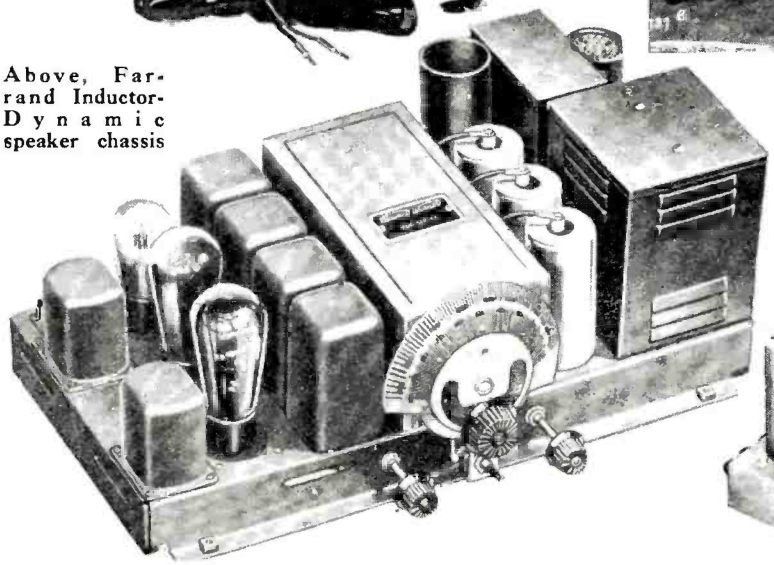


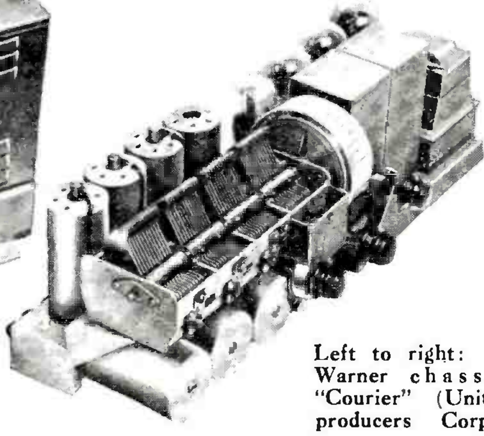




Above, Superior Cabinet Corp. console for Atwater Kent; at the left, the new Ware radio console (Ware Manufacturing Company)

Above, Farrand Inductor-Dynamic speaker chassis

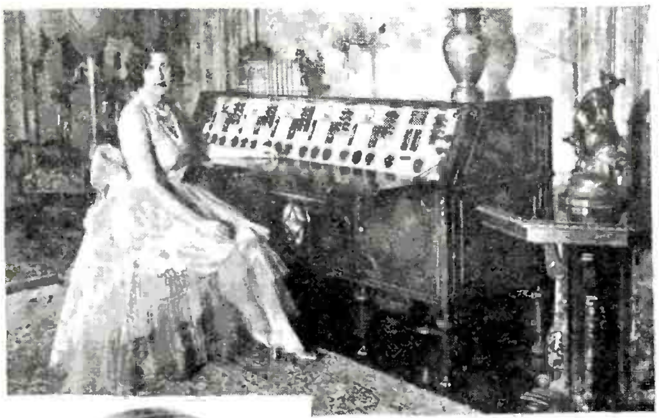


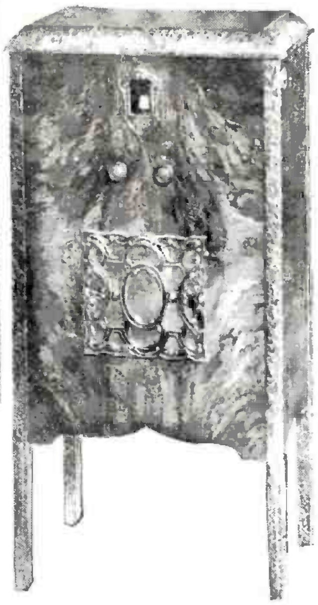


Left to right: Stewart-Warner chassis, and "Courier" (United Reproducers Corporation)

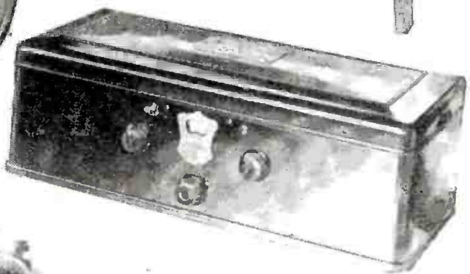
Loud Speaker Characteristics

Manufacturer	Model	Type	Size of Cone	Type of Rectifier
Kersten *Kersten Radio Equip.Co.*	D-221	Dynamic	8″	Dry Disc
	M-120	Magnetic	9″	None
	D-C-33	Dynamic	8″	100-120 Volt D.C.
	D-C-44	"	"	6 Volt to 220 Volt
	No. 4	"	"	D.C. Field— Dry Disc
	No. 2 Cabinet	Magnetic	9″	None
	No. 3 Cabinet	Dynamic	8″	Dry Disc
	Kersten Grand	Magnetic	9″	None
	KerstenCabinet	"	"	"
Magnavox *The Magnavox Co.*	Carillon	Cabinet Only		
	Aristocrat	"		
	Stratford	"		
	Campanile	"		
Speakers	No. 106	Dynamic	7¾″	110-190 V.D.C.
	No. 107	"	10½″	"
	No. 108	"	7¾″	180-300 V. D.C.
	No. 109	"	10¼″	"
	No. 200	"	7¾″	6-12 V. D.C.
	No. 201	"	10¼″	"
	No. 400	"	7¾″	105-120 V. A.C. Dry Rectifier
	No. 401	"	10¾″	"
	No. 402	"	7¼″	105-120 V. A.C. Dry Rectifier
	No. 403	"	10¾″	"
Muter *Leslie F. Muter Co.*	4310 For 110 V. 60 cycles.	Dynamic	9″	'80 Tube
	4311 For 110 V. 25 cycles.	"	"	"
	4410 For D.C. 90 volt, 2300 ohms, 40 M. A. drain.	"	"	"
	4390	"	"	None
	4306	"	"	"
	For D.C. 6 volt 4411	"	"	'80 Tube
	4490	"	"	None
	4406	"	"	"
	4510	"	"	'80 Tube
	4511	"	"	"
	4590	"	"	None
	4506	"	"	"
Nathaniel *Baldwin*	D-29	Dynamic	9″	Dry Disc
	"	"	"	110-120 Volt D.C. 2500 to 5000 Ohms D.C.
	E-29	Electronetic	"	
	29	Magnetic	7″	
O'Neil *O' Neil Mfg. Co.*	33-A	Dynamic	9″	Dry Disc 110 V.A.C.
	25-D	"	"	110 Volt D.C.
	29-D	"	12½″	"
Operadio *Operadio Mfg. Co.*	2106	Dynamic	9″	110 Volt D. C. 110 V. A. C.
	2306	"	"	Tube Rec.
	Conamic	Magnetic	11½″	
	Parisienne	"	"	"
	St. Charles	Dynamic	9″	110 V. D.C.
	Jack Horner	"	"	110 V. D.C.
Oxford *Oxford Radio Corp.*	35, 34, 33, 32, 31	Dynamic	10″	Tube Rec.
	43	"	8″	"
	23	"	8″ & 10″	Dry
Philco	Mantel	Dynamic	10″	Tube Rectifier
Quam	C	Magnetic	"	None
Peerless	17-AR-60	Dynamic	7″	Dry Disc
	17-AR-30	"	"	25-40 Cycle
	17-AD-6	"	"	6 Volt
	17-AD-32	"	"	32 Volt D.C.
	17-AD-110	"	"	110 V. D.C.
	19-AR-60	"	9″	Dry Rec.
	19-AR-30	"	"	Dry Disc 25-40 Cycles
	19-AD-6	"	"	6 Volt D.C.
	19-AD-32	"	"	32 Volt D.C.
	19-AD-110	"	"	110 Volt D.C.
	19-TR-60	"	"	Dry Disc
	19-TR-30	"	"	Dry Disc 25-40 Cycles
	19-TD-6	"	"	6 Volt D. C.
	19-TD-32	"	"	32 Volt D.C.
	19-TD-110	"	"	110 V. D.C.
Radiola *RadioCorp. of America*	100-A	Magnetic	7″	
	103	"	"	
	100-B	"	"	
	106	Dynamic	8″	Dry Disc
"Reproduco" *Operators Piano Co.*	R-10 A.C.	Dynamic	9″	Dry Disc
	R-90	"	"	None
Rola *The Rola Co.*	J-6	Dynamic	7⅝	6 Volt D.C. 6 Volt D. C.
	J-6-2	"	"	With Push-Pull Tr.
	J-90	"	"	90 Volt D. C.
	J-90-2	"	"	Do. With Push-Pull Trans.
	J-110	"	"	Dry
	J-110-2	"	"	Do. Push-Pull Trans
	J-180	"	"	150-225 V. D.C.
	J-180-2	"	"	Do. Push-Pull
	J-160	"	"	5000 Ohm D.C.
	J-2	"	"	Do. Push-Pull
	J-6-M	"	"	Six Volt D.C.
	J-90-M	"	"	90 Volt D.C.
	J-160-M	"	"	5000 Ohm D.C.
	J-180-M	"	"	150-225 V. D. C.
	J-90-L	"	"	Dry Westinghouse
	30-J	"	"	None
	15	Magnetic		"
	20	"		"
	"M"	"		"
	C-110	Dynamic	9″	Westinghouse Dry Disc
	C-110-2	"	"	Do. Push-Pull Transformer
	C-6	"	"	6 Volt D. C.
	C-6-2	"	"	6 V. D.C. Push-Pull
	C-180	"	"	150-225 V. D.C.
	C-180-2	"	"	Do. Push-Pull
	C-90	"	"	90 Volt D. C.
	C-90-2	"	"	Do. Push-Pull
	C-6-M	"	"	6 Volt D. C.
	C-180-M	"	"	5000 Ohm D.C.
	C-90-M	"	"	90 Volt D.C.
	"RAC"	"	12″	Tube (80)
	Auditorium	"	9″	'80 Rectifier Tube
Silver	851	Dynamic	9″	(80)
Marshall *Silver-Marshall Inc.*	841	"	"	90 Volt D. C.
Sterling	R-13-C	Dynamic	7″	Dry Disc
	R-250	Dynamic Speaker		
	DYN Amplifier	Amplifier Only	None	
Stewart-Warner	No. 441, No. 442	"Dyphonic"	7″	None
"Symington" *Valley Appliances, Inc.*	Chassis	Dynamic	7½″	'80 Tube
	"	"	10″	'80 Tube
Temple *Temple, Inc*	No. 5	Magnetic	9″	None
	No. 17	Magnetic	54″	"
		Air Column	Air column	"
	Chassis	Dynamic	9″	Dry
	Cabinet Model	"	"	"
"T. C. A." *Transformer Corporation of America*	A. C., D. C.	Dynamic	9⅜″	Optional
Utah *Utah Radio Products Co.*	X-15, X-20, "M", "B"	Magnetic	9″	None
	Dynalo Cabinet	Dynamic	"	Dry Disc.
	"	"	"	110 V. D. C.
	"	"	"	None
	65	"	"	Dry Disc
	"	"	"	110 V. D. C.
	"	"	"	None
	33-A	"	"	Dry Disc
	43-D	"	"	110 V. D. C.
	53-R	"	"	None
	Stadium 66-A	"	12¼″	
	Stadium 76-D	"	"	
Wright-de Coster *Wright-De-Coster, Inc.*	107	Dynamic	10″	Dry Disc 25-60 Cycle
	107-T	"	12″	" "
	108	"	"	" "
	108-T	"	"	" "
	Wood Horn No. 9	Horn Only	48″ long Bell 30″ x21½″	None
	Wood Horn No. 5	"	48″ long Bell 23″ x22″	"

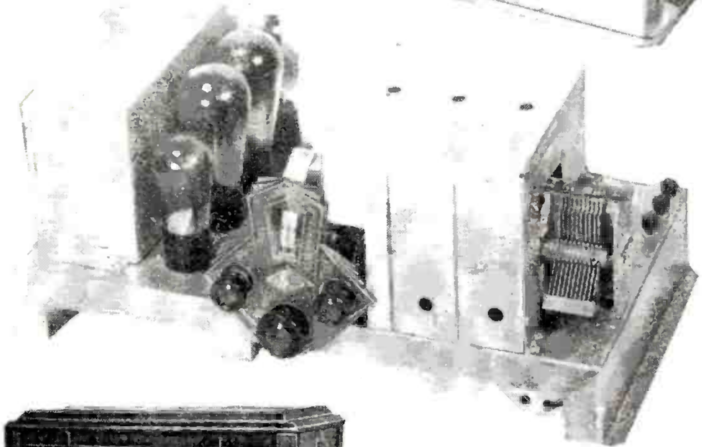




Above, Crosley model 43S (Crosley Radio Corporation); at the left, Sterling Mfg. Company Console

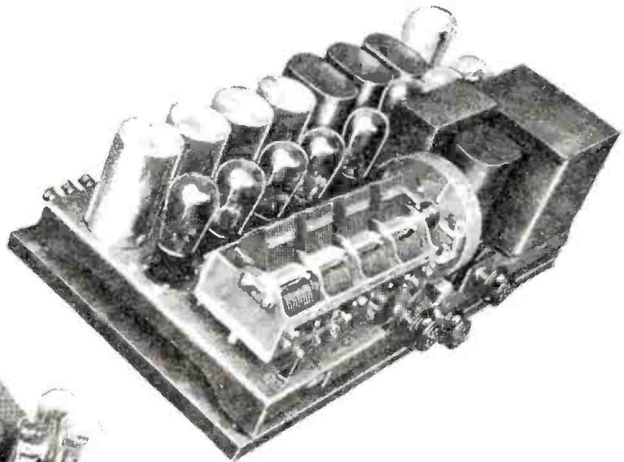


Above, Silver Ghost receiver (C. R. Leutz, Inc); below, Atwater Kent table model set and speaker

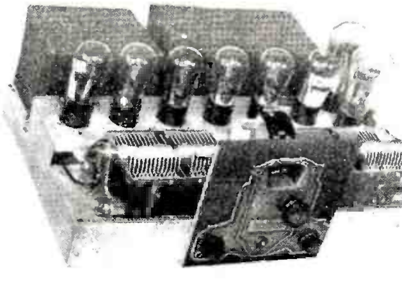


Above, Silver - Marshall chassis No. 722; at the right, above, Fada Highboy (F.A.D. Andrea, Inc.); below, chassis of the Metrodyne receiver

Above, R. C. A. superheterodyne (Radio-Victor Corporation)



Above, chassis of Brunswick Radio (Brunswick-Balke, Collender Co.)



The Radio Forum

A Meeting Place for Experimenter, Serviceman and Short-Wave Enthusiast

The Experimenter

Students of radio receiver circuits often ask how it is possible to provide different grid bias voltages on various tubes when the grid returns are all connected to the same point, namely, the negative terminal of the B battery eliminator. That this question, says Mr. J. E. Anderson, of New York City, should be confusing is no wonder, for often the circuits are drawn in such a complex and intricate manner that even one well versed in the subject often must analyze the circuit before he is sure of the various voltages applied.

But a circuit may be drawn so that it is just as easy to tell the various voltages as it is to tell which is up and which is down. It is then only necessary to remember that the positive terminal on the plate voltage supply is up with respect to any other point in the circuit, and that the negative terminal is down with respect to any chosen point. It should also be remembered that the filament or the cathode of any tube is the point from which the plate and grid voltages are measured with respect to that tube.

Simplified Circuit

Fig. 1 shows a typical transformer coupled audio amplifier with grid bias detector. The filaments of this circuit are heated with a. c. because it is in this type of circuit where the voltages are most confusing. A separate grid bias resistor is used for each tube in order to more clearly show the voltages.

R4 and R5 are two resistor sections in the B battery eliminator voltage divider. Only three of the binding posts on the eliminator are shown. The plate returns of the first two tubes go to the 135 volt point on the voltage divider, the voltage being measured from B minus. The plate return of the power tube is connected to the highest point on the eliminator, which is 220 volts above B minus.

The plate current flows from the taps on the voltage divider toward the plate. Since the primaries of the transformers T1 and T2 have some resistance, the voltage at the plates is less than at the B plus end of the transformers. The current flows from the plates to the cathodes. Since there is a high resistance between the plate and cathode, there is a considerable voltage drop between these elements. This drop is the effective plate voltage on the tubes.

But the current continues to flow down through the grid bias resistors. There is an additional drop in them and this drop is the grid bias. The drop in the resistance R5 is equal to the drops in the primaries, the plate to cathode resistance and the grid bias resistors.

When laying out a panel, base, etc., be sure to make accurate markings by means of a scriber and square

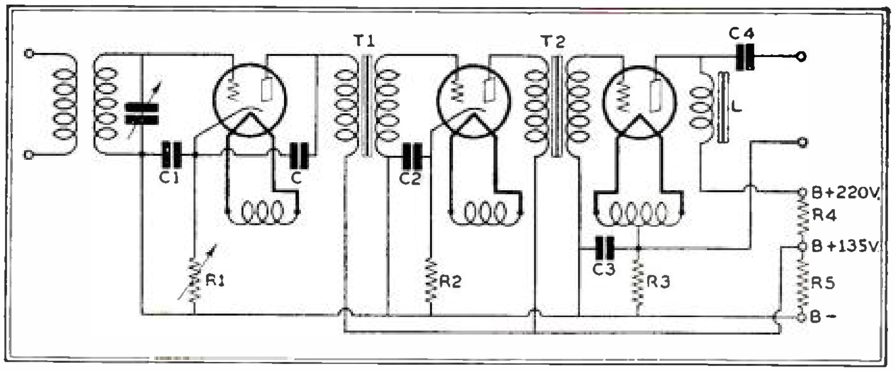


Fig. 1

Voltages in Power Tube

The same thing happens in the power tube. There is a total voltage drop of 220 volts available, which is the drop in R4 and R5. This drop is equal to the drops in the choke coil L, the plate to filament resistance and the grid bias resistor R3.

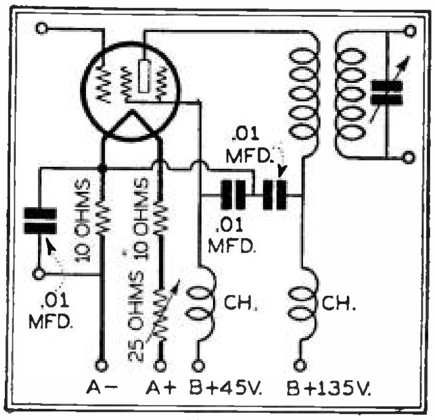


Fig. 2

In order to get the proper voltages on the tubes, it is only necessary to proportion the grid bias resistors and the plate resistances properly. The detector tube requires a high negative bias for best results. Hence R1 is made large, and it is also made variable because the required bias is critical. The other two bias resistors, R2 and R3, may be fixed. The values depend more on the tubes used than on the total voltages applied.

Keeping the cell covers and terminal posts of a storage battery clean by means of an ammonia wash lengthens the battery's useful life

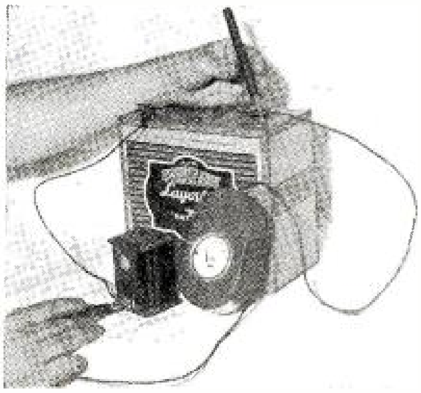
It will be observed that all the grid returns are connected to the same point, namely, B minus. Yet there is a different grid bias on each tube because there is a different voltage drop in each of the resistors, R1, R2 and R3.

Another problem that arises frequently is the connection of by-pass condensers. When possible all by-pass condensers should be connected from the

(*Continued on page* 360)

The Serviceman

"Many times," says Mr. D. A. Brown. of Marion, Ohio, "the serviceman and the set builder run across small fixed condensers on which there is no capacity marking and also when he would like to know the capacity of various components of a set. A simple device for determining this can be constructed at a maximum



When making continuity tests, a voltmeter and "B" battery are important items

cost of $9. The device employs the capacity bridge principle, similar to that used in the laboratory test equipment. Our capacity bridge uses either the common a. c. or an audio oscillator for a resonance indicator.

The connections are shown in Fig. 1. In order to place the bridge in operation it is first necessary to balance it perfectly. This is done by inserting a fixed condenser of .001 mfd. as C1. This condenser should be of a high grade mica insulation type. By listening in on the phones

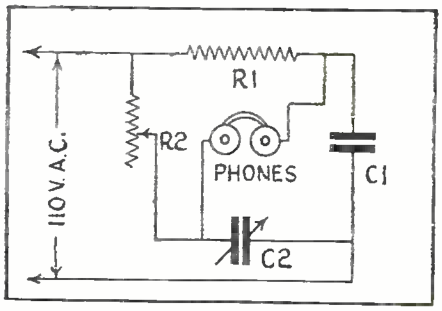


Fig. 1

and varying the resistance R2 and the condenser C2 the a. c. hum can be entirely eliminated. The bridge is now balanced and the resistance R2 should be left in this position permanently. All future adjustments are made with C2. When the hum disappears (resonance point) C2 will be practically at maximum. Now our capacity bridge is ready for testing unknown capacities. Remove the condenser C1 which we use only for preliminary adjustments, and in its place insert the condenser to be tested. Then vary dial on C2 until the a. c. hum disappears. At this point the dial setting of the condenser C2 indicates the capacity of the condenser under the test. C2 being of a straight line capacity type and equipped with 0 to 100° dial, the capacity of the condenser under test may be read directly from the dial set. In other words, if the a. c. hum disappears at 50° on the C2 dial, then the condenser on test is half of the standard or .0005 mfd. A dial reading of 25 would be .00025 mfd, or the condenser on test and the dial reading would be ¼ of the maximum capacity of the standard. A parallel or series group on condensers may be tested in this circuit providing of course the unknown capacity is not below the minimum or above the maximum of the standard C2. A 25 watt lamp is inserted in the 110 volt a. c. line, to limit the current in case one of the condensers on test

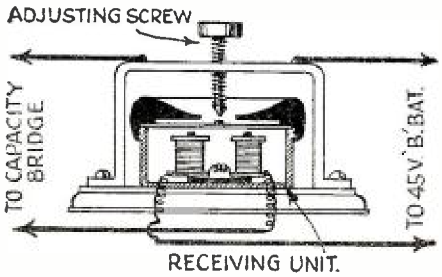


Fig. 2

breaks down. If the condenser is shorter the lamp will glow very red and if condenser is open it will be impossible to balance the circuit. For the average experimenter the 110 volt a. c. line will serve as a good resonance indicator, but better and sharper results may be had if the 110 volts a. c. line is replaced with an audio oscillator or microphone hummer. A microphone hummer is shown in Fig. 2. This hummer is made up from an old receiver or loud speaker unit.

Mr. Brown has also devised a method of obtaining a field supply for the dynamic speaker testing. This tester, as

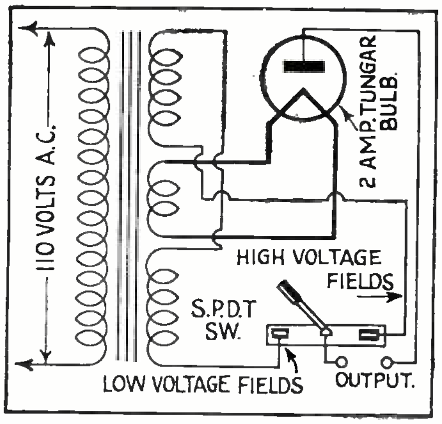
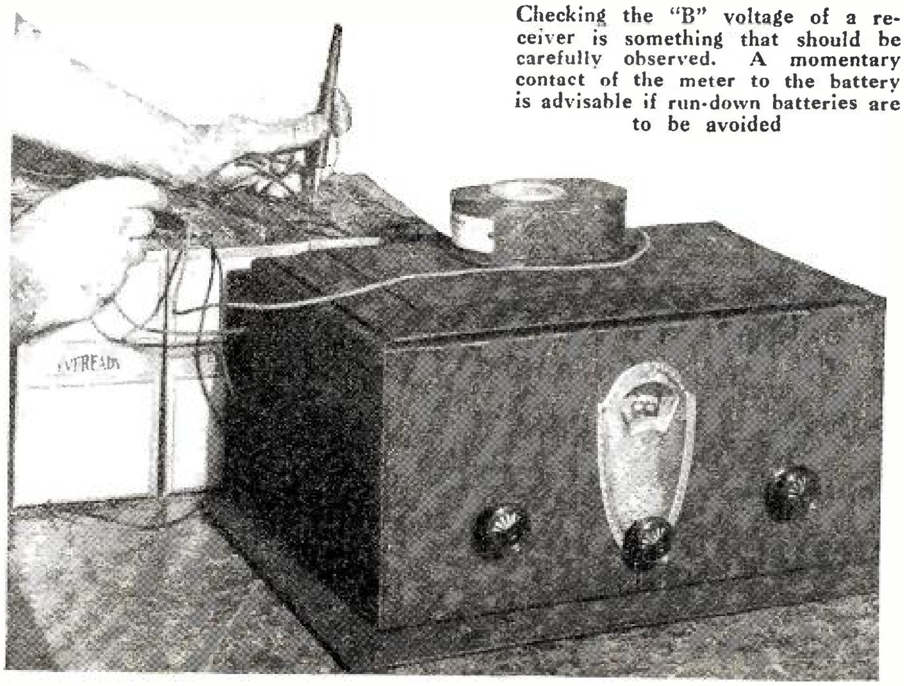


Fig. 3

shown in Fig. 3, saves considerable time when a speaker is brought in for repairs and the field supply system has been left on the job. As the bringing into the repair station the filed supply system, would mean dismantling quite a portion of the set equipment. A battery charger of the tungar type is used as a current supply for making tests. The output of this type of charger is usually around 6 volts for "A" battery charging. This will furnish the field current for the low voltage excitation of the field coil. The high voltage tap on the charger used to charge "B" batteries supplies around 100 volts which will also furnish the field current for the high voltage type of dynamic speaker. A small single pole double throw switch, shown in Fig. 3, allows a ready method of changing the voltages. A charger so equipped has been used in service work by myself with considerable satisfaction and for the repair man who likes current supply in compact unit this furnishes a reliable source which, when not used for this type of work, can be used for its specific purpose of charging batteries.



Checking the "B" voltage of a receiver is something that should be carefully observed. A momentary contact of the meter to the battery is advisable if run-down batteries are to be avoided

On Short Waves

Regeneration

Before discussing regenerative action as applied to short-wave receivers, let us open up the radio dictionary, stopping at that word. "Regeneration is the action by which a part of the energy from the plate circuit of a tube is fed back into the grid circuit of the same tube. The plate circuit energy is added to the energy already in the grid circuit.

The outline of any subject is easier understood when circuit drawings are used So let us begin by referring to Fig. 1, where is shown a three element vacuum tube, with its associated inductance and the capacity in the grid circuit

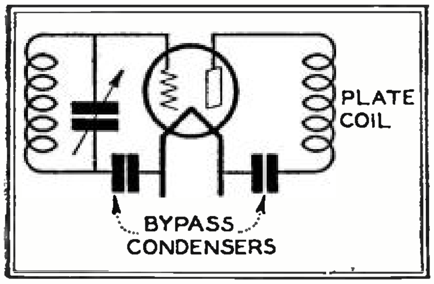


Fig. 1

and inductance in the plate circuit. The grid portion of this circuit is known as the input circuit of the tube, and the plate portion as the output circuit. The impressed signal on the grid circuit and the voltage changes in the signal cause corresponding voltage changes on the grid of the tube. These varying voltage changes on the grid of the tube, control the flow of a greatly magnified current in the plate circuit. Therefore, the strength of the output energy in the plate circuit is directly proportional to the impressed voltage on the grid of the tube. It necessarily follows that if the signal strength is increased at the input of the circuit, greater current flow will result in the output circuit. Of course, many methods are available to increase the strength of the input signal. For example, a stronger signal is impressed on the input circuit when operated near a stronger

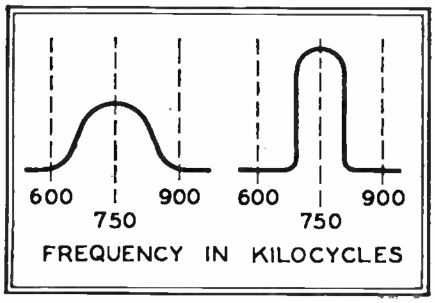


Fig. 2

broadcaster than from a distant, weak transmitter. However, we cannot all change our location to be near or in the neighborhood of a powerful transmitter. Regeneration then comes to our aid, whereby the regenerative action is employed to obtain a material increase in the input voltage applied to the input circuit.

When the grid circuit of a detector tube is tuned to resonance with the frequency of the incoming signal, the inductive reactance and the capacitive reaction in this circuit neutralize each other, leaving only the resistance of the associated

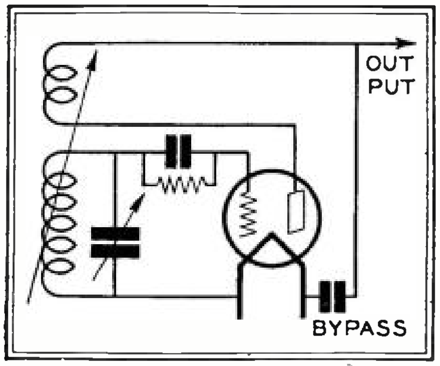
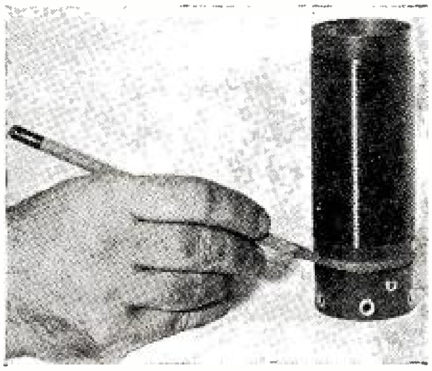


Fig. 3

apparatus to oppose the flow of current. If it were possible to reduce this resistance to zero, nothing would remain to oppose the current flow, so that once oscillating voltages are introduced in the circuit, they would continue indefinitely.



Fixed coupling between secondary and tickler coils makes it possible to calibrate detector tuning circuits with a fair degree of permanency and accuracy

Fact follows theory then that similar results may be obtained if just enough energy is added to that already in the grid circuit, so that the "added energy" supplied is sufficient to overcome the resistance losses. The added energy for the grid circuit may be obtained from the plate circuit as the maximum energy in the plate circuit is at the same frequency as that of the grid circuit. Resistance losses can therefore be overcome by feeding back the plate energy to the grid circuit. Sustained oscillations, independent of the incoming signal, will result with slight additional plate feedback, after resistance losses have been overcome. Just so long as the grid circuit absorbs energy from the incoming signal, is the tube in regeneration, with feedback in use. However, when the feedback is increased beyond this point, oscillation occurs, and will be sustained as long as the filament and plate supply last.

It will be seen that with the proper amount of regeneration that a weak signal can be built up materially. Thus, regeneration increases the sensitivity of the circuit as well as the selectivity.

In Fig. 2 the curve at the left graphically shows the side band of a receiver tuned at 750 kc. where the losses have not been overcome, while the curve at the right is "with regeneration." Since regeneration occurs at only the frequency to which the grid and plate circuits are tuned, it will be found that the frequencies 600 and 900 kc. remain at the same signal level as in the curve at the left. Fig. 2. A peculiarity with regeneration is that feedback occurs more easily at high frequencies. It is therefore necessary to control the feedback energy. This may be accomplished by a number of different methods, all providing smooth operation or as the short-wave fan expresses it, "sneaking up."

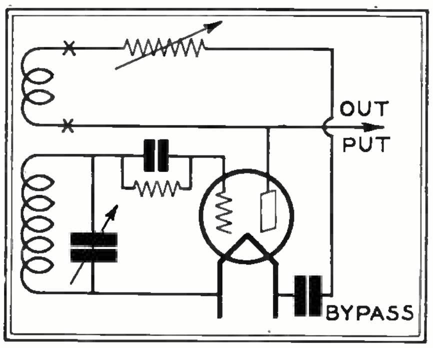


Fig. 4

Most generally used is the rotating tickler method shown in Fig. 3. The tuned secondary winding is wound on a stationary form and the tickler on a form slightly smaller in diameter than the secondary. This tickler rotates within the secondary winding. An extension shaft, complete with knob, controls the relationship between the secondary and tickler windings. As the tickler is rotated to increase its coupling to the secondary winding, the effective inductance of the tuned secondary coil is increased. It necessarily follows, therefore, that the tuning point

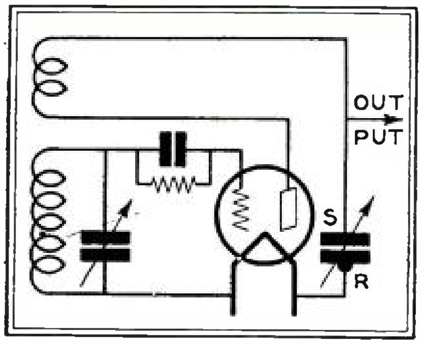


Fig. 5

at which the circuit resonates to a specified frequency will change with changes of the tickler adjustment. These changes produce a rather serious disadvantage in that the tuning circuit cannot be logged unless, of course, the dial reading for the tickler is noted as well as that of the secondary tuning circuit. When the voltages of the secondary and tickler coils are

(*Continued on page* 373)

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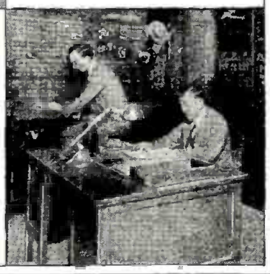

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The Junior Radio Guild

(*Continued from page* 341)

Like the knife, the magnetic field must be made to move before it can accomplish its work.

Audio Frequency Transformers and What They Consist Of

There are many styles and types of audio frequency transformers available today, but essentially they are alike in that they consist of a primary winding, a secondary winding, and a metallic core.

The most common type employs a core consisting of many layers of sheet metal, usually silicon steel, which are termed laminations. These laminations have three legs jutting out from a common side much like the letter "E."

The primary winding consists of many thousands of turns of fine wire wound on a spool or insulated tube, large enough in inside diameter so that it may readily be slipped over the center leg of the laminated core.

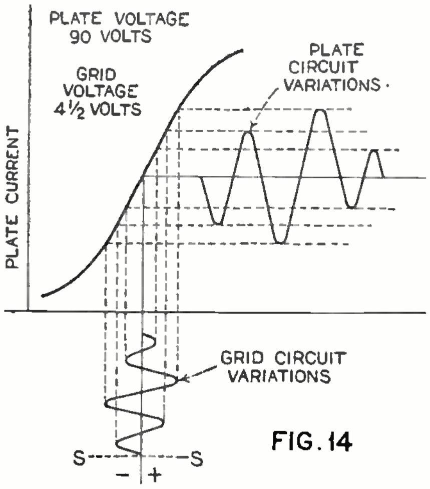


FIG. 14

Due to the amplifying action of the tube a weak signal impressed on the grid is enlarged or magnified in the plate circuit

The secondary coil is wound directly over the primary coil, being separated from the latter by several layers of insulating cloth. This secondary consists of many more turns than the primary, and is usually wound with a finer wire. The number of turns by which the secondary is increased over the primary depends upon the ratio desired between the windings. If a transformer is rated at 3 to 1 or 5 to 1, then the secondary will have three times as many turns as the primary in the first instance and five times as many in the latter instance.

The coil assembly consisting of the primary and the secondary windings has its center hole filled with a pile of laminations, half with the legs of the "E" facing in one direction and the other half facing in the other. The laminations are inserted one by one, the direction of the legs being faced alternately in one direction and then the other. When the core center has been filled, the laminations are clamped at the ends by straps of metal to prevent their working loose. Then the entire unit is enclosed in a metal can which acts as a shield so as to prevent the magnetic field of one transformer from intercoupling with an adjacent one. Suitable terminals are mounted on the shield can and insulated therefrom.

For details concerning the assembly of a transformer, see Fig. 15.

How the Audio Frequency Amplifier Tube Works

A glance at the amplifier circuit, Fig. 13, will show that the terminals of the secondary coil of the first audio frequency transformer are connected to the grid and filament of the succeeding tube. The filament connection is made through the C battery lead which terminates at that particular value of C voltage which is required for the type of tube employed. Normally, first stage amplifier tubes require from 3 to 4½ volts of C battery to make them function satisfactorily. This C bias, as it is called, adjusts the tube to its correct operating characteristics and insures that, provided the proper amount of filament and plate voltage are employed, the tube will function successfully.

In Fig. 14 is shown the grid voltage-plate current characteristic curve of a first stage amplifier tube and indicates how the applied signal is amplified or enlarged through the amplifying action of the tube. It will be observed that unlike the characteristic curve for the detector tube, shown in Lesson No. 2, the signal is applied to the straight portion of the curve instead of the bended portion as in the case of the detector. Following the action through the tube,

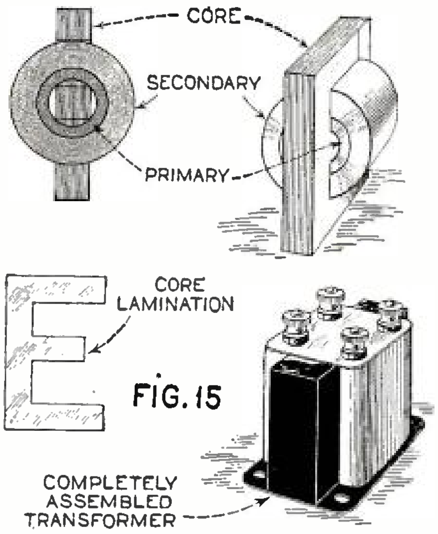


FIG. 15

An audio-frequency transformer in principle is much like the electro-magnet illustrated in Fig. 12. Two coils, a metallic core and a shell comprise the entire unit

it will be seen that the applied signal, indicated by the line S . . . S at the bottom of the figure causes a great variation in the plate current and in general enlarges the entire pattern of the applied signal, the while not changing its character.

As in the case of the detector tube, the electrons emitted by the hot filament are attracted to the plate which is of positive polarity. When a positive alternation of the applied signal reaches the grid, the attraction of the electrons toward the plate are aided. If the positive alternation be great, then a great amount of plate current will flow. If the positive alternation be not so great, then a lesser amount of plate current will flow. When a negative alternation reaches the grid of the tube it retards the flow of electrons to the plate, thus causing a falling off in the plate current. If the negative alternation be great, then correspondingly the falling off will be great. If the negative alternation be small, then the falling off will be correspondingly small.

Here, then, we have the same action or results which were produced in the plate circuit of the detector tube. The application of an alternating current to the grid of the tube releases currents in the plate circuit of varying amounts or strengths.

The action between the first audio frequency tube and the second amplifying tube is essentially the same as that just described, the difference being that in the plate circuit of the second audio stage is connected the loud speaker, which is more or less an enlarged or overgrown version of the head phones first used in the plate circuit of the detector stage.

How to Construct a Two-Stage Audio Frequency Amplifier

The parts used in the assembly and construction of the audio amplifier are two Thordason 3½ to 1 audio transformers, two sockets and two type 1A amperites. It is recommended that the reader obtain these parts and then proceed as follows:

First, study the photographic illustration on page 341 and the parts wiring diagram, Fig. 16, on separate sheet. Note the position of the transformers, the sockets and the amperites. Then temporarily place these parts on the baseboard of your receiver, getting them in approximately the same position as that shown in the photograph. To do this you may have to remove the two Fahnestock clips, which were previously used to take the phone tips.

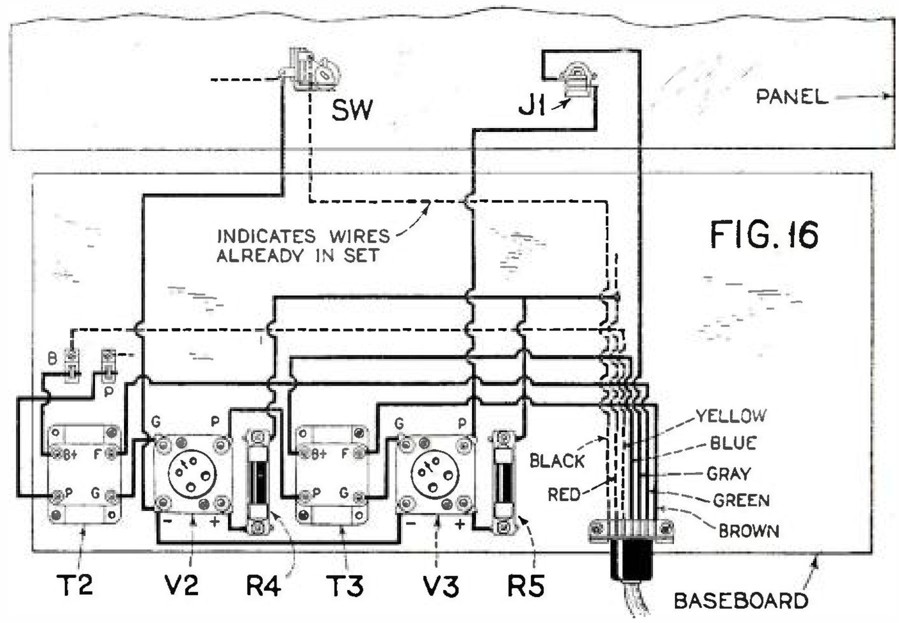
In locating these parts on the baseboard as shown, it is important that the individual units be placed so that their terminals coincide with the layout as shown on the separate sheet.

Looking over the top of the panel towards the rear edge of the baseboard the transformers should be placed so as to have their "Pos. B" and "Plate" terminals to the right side and the "Neg. Fil." and "Grid" to the left.

The sockets should be placed so that the two filament terminals are towards the back, while the grid and plate terminals are to the front. The mounts for the amperites may simply be placed alongside the left side of the sockets.

The position of the new parts should be compared with and aligned with those parts already mounted on the baseboard, such as those for the detector unit. For instance, it will be noted that the amperite for the second audio stage is directly in line with the drum dial. Likewise, the amperite for the first audio stage is directly in line with the "plate" post or terminal of the detector tube socket. The right edge of the first audio transformer is almost flush with the edge of the baseboard, while the second audio transformer is directly behind the de-

(*Continued on page 366*)



The picture wiring diagram of the audio channel should be compared with the circuit diagram, Fig. 13, for a clear understanding of the connections which are to be made

The Personality Behind the Ghost Hour

(*Continued from page 317*)

It is entirely mechanical, yet plays chess and checkers, draws selected cards, and acts lifelike in various other uncanny demonstrations. To the writer's knowledge, it is the only automaton in the world that is governed exclusively by mechanical action. Through the kindness of Beatrice Houdini, Dunninger also became the possessor of a large array of spiritualistic records, photographs, and various psychic data, which had been compiled by the late Houdini in his many years of research.

As an author, this man ranks among the foremost in work pertaining to the mystic. Among the books that he is accredited with, are *Universal Second Sight, Tricks Deluxe, Tricks Unique, Popular Magic (Volumes One, Two and Three), Houdini's Spirit Exposés, and Dunninger's Psychic Investigations.*

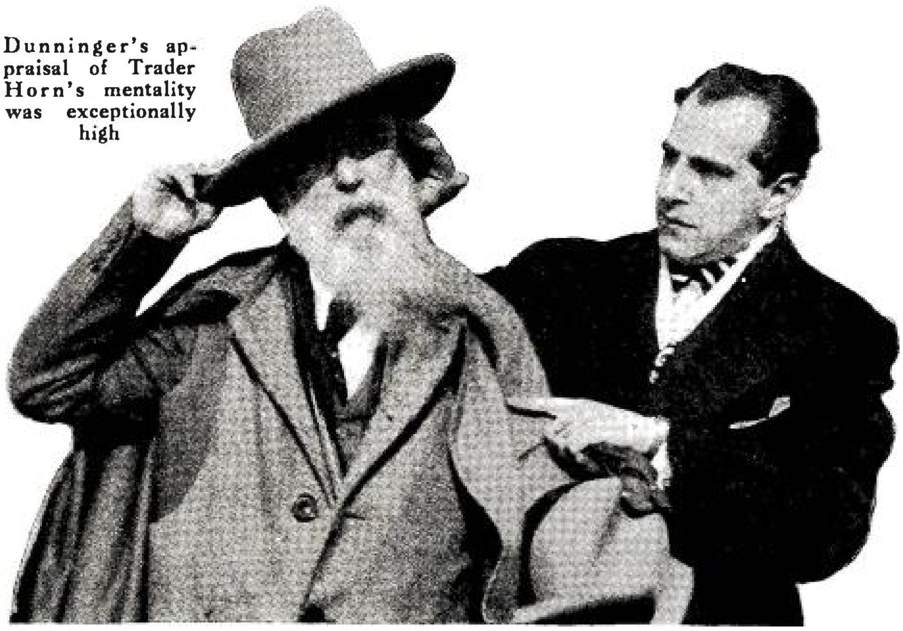
For years this mentalist has been chairman of the Scientific Investigation Committee of *Science and Invention Magazine,* which publication has a standing reward of $21,000, payable to any medium in the world who is capable of presenting any effect in so-called spiritualism or psychic phenomena which Dunninger would be unable to duplicate by natural or scientific means. Needless to say, hundreds of mediums have applied for this prize, but to date none has been able to offer sincere evidence of psychic ability when subjected to the searching eyes and keen analysis of this investigator.

One of the greatest mediums of all time, in the personage of Nino Pecoraro, a young Italian materializing medium, became a subject of Dunninger's investigation, and succeeded in presenting a most impressive seance, in which much of a spooky and uncanny nature was produced. Dunninger, however, easily duplicated all of the medium's wares under similar conditions, and produced much of a phenomenal nature, by scientific means, which even the medium could not produce by his self-styled spirit power.

It is amusing to find how many of the various magazines devoted to spiritualism have been offering accounts of Dunninger's work, and insisting that he is possessed of "spiritualistic power" which he does not in the least admit. Dunninger's scientific demonstrations and constant analysis of the things he does, seems to have absolutely no bearing upon their repeated opinion.

The investigator's daring and fearless attitude might be well expressed in the fact that he recently ventured to appear at a seance at the spiritualist's convention, in New York, and flung a challenge to John Slater, a message bearer, while Slater was demonstrating his so-called "spirit power" before a gathering of over two thousand believers, who were assembled from the four corners of the world. Although the spiritualists succeeded in evicting Dunninger from the auditorium, Slater did not succeed in reading a message in a sealed envelope, for which Dunninger offered a reward of $21,000, and for which he held his check in evidence of his sincerity. The name of Ponzi, the meteoric wizard of high finance, remains vividly in the minds of newspaper readers. Ponzi was for a brief time a master of finance, through whose amazing ability the entire world stood in awe. Dunninger was appearing at Steinert Hall, in Boston, at the height of Ponzi's reign. One of the editors of a Boston paper influenced him to meet Ponzi, and it was through his mental investigation of Ponzi's mind that sufficient evidence was supplied to the authorities eventually to lead to the exposure of this money wizard's methods.

A most interesting experience during Dunninger's career was one in which he was called to assist in the solving of a prominent murder case, of a high police official, in Washington, D. C. He solved,



Dunninger's appraisal of Trader Horn's mentality was exceptionally high

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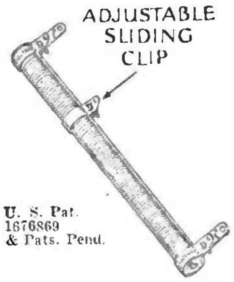

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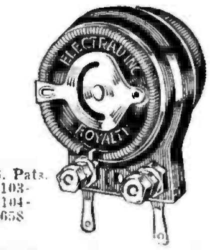

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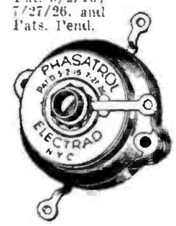

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The Experimenter

(*Continued from page 350*)

cathode or the filament to the various points. This is a better connection than using B minus as the starting point. Thus in Fig. 1 "C" the by-pass condenser in the plate circuit of the detector is connected from the plate to the cathode and not to B minus as is often done. Referring to the connections of C1, C2 and C3, there is no alternative.

Connection of Speaker

Concerning the connection of the loud speaker, there are three different choices in a circuit of the type shown in Fig. 1. It could be connected across the choke coil L, and this connection is often used. When this is used, the signal current must go through the eliminator. Common coupling results. It could also be connected from the plate to B minus. The signal current is then forced through the grid bias resistor. Reversed feedback results and a decrease in the output, particularly on the low notes where the by-pass condensers are ineffective.

The third method is illustrated in Fig. 1. The speaker returns to the filament. There is no reversed feedback and no signal current through the eliminator, except that which goes through the choke coil. This is small, so the method illustrated is by far the best.

But this connection is not applicable when the output device is a transformer or when the speaker is connected directly in the plate circuit. But in those cases, a large condenser may be connected from the filament to the B plus side of the speaker or the transformer.

Volume Control in A. C. Circuits

One of the difficulties with a. c. circuits is to provide a suitable and adequate volume control. A variable resistor may be placed in the antenna. Usually this is not adequate, although it is very good as far as control of volume is concerned. A very good control is illustrated in Fig. 1. If the variable grid bias resistor R1 is made large enough and has a low minimum, it may be used to control the volume effectively. It not only changes the grid bias and so controls the volume, but it also varies the total resistance in the plate circuit. Hence, it serves both to vary the bias and to introduce a resistance in the plate circuit.

Operation of Screen Grid Tube

Screen-grid amplifiers are often inserted in receivers in the hope that high amplification and stability will be achieved. Not infrequently the change in the circuit accomplishes neither. The reason is usually that necessary precautions have not been taken. To gain stability with high amplification every precaution must be taken to prevent feedback and to gain high amplification, the proper voltages must be applied. The load impedance must also be high.

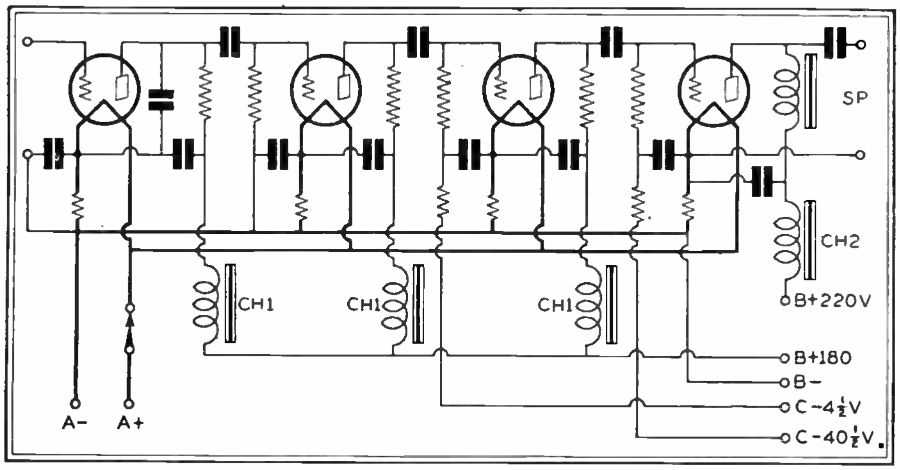


Fig. 3

The grid bias should be about 1.5 volts. If the entire filament ballast resistor is placed in the negative leg of the filament and the grid return is connected to A minus, the bias is too high. It is better to put 10 ohms in each leg as illustrated in Fig. 2. If a volume control is put in the filament circuit, it should be put in the positive leg. About 25 ohms is a suitable value.

Stability is achieved by filtering the leads and by shielding the entire stage, not only the tube alone. The connection of the filter condensers is shown in the diagram. Note that all of them are connected to the negative end of the filament. One condenser is across the grid bias resistor, another across the screen-grid and a third across the plate supply. A suitable value for each of these in a radio frequency circuit is .01 mfd.

A radio-frequency choke coil of 85 millihenries is put in series with each of the screen-grid and plate leads.

A necessary condition for high amplification is that the load impedance be high. That is, the primary winding on the coupling coil should be large and it should be closely coupled to the second-

ary. Fine wire on the primary is recommended.

Motorboating and Howling

The greatest trouble in amplifiers is motorboating and howling. The disturbances may have any frequency from a slow waxing and waning of the signal similar to very slow fading to a superaudible frequency. Sometimes the noise is due to microphonic tubes but in most cases it is due to low frequency feed back. If due to microphonic tubes, the noise can be usually stopped by employing a different detector tube or by protecting the tube from the sound waves emitting from the speaker.

If the trouble is due to feed back, it is difficult to stop. The feed back takes place in most instances through the B battery eliminator or the batteries. When it does it is termed "motorboating" whether or not the frequency is audible.

Motorboating rarely takes place except in the very best amplifiers. But if the B battery eliminator is inadequately bypassed, it may take place in any amplifier having two or more stages.

The remedies for this condition are based on isolating the different stages so that there is no feed back, or on reducing the amplification of the circuit at the frequency of the disturbance.

If the noise is above the middle register, just plain by-passing of the plate leads is usually sufficient. If the disturbance is at a very low frequency, by-pass condensers do not help much. But if the circuit is direct coupled, a reduction of the stopping condenser or of the grid leak resistance is effective. In severe cases both may have to be reduced. Suitable filtering helps. Fig. 3 shows a resistance-coupled amplifier in which a thorough job of filtering has been done to eliminate as much as possible the cause of motorboating.

Placement of By-Pass Condensers

All the by-pass condensers in this circuit are connected to the filament of the tube with which they are associated, and not to the B minus lead. Condensers are not only used in each plate circuit, but also in each grid circuit.

In addition to the condensers, a filter choke is used in series with each plate and a resistor in each of the last two grid leads. These resistors are used because the grid bias is taken from a drop in the B battery eliminator voltage divider. The first three series chokes may be replaced by resistors of about 10,000 ohms. The fourth choke, CH2, should in all cases be a choke of low resistance; it may be of the same type as the coupling choke in the same plate circuit.

The larger the by-pass condensers across the grid and plate leads, the better will be the filtering. It may seem a waste of condensers to some but they are the price of stability and the highest quality. The circuit which has been treated like the one in Fig. 3 will have a response characteristic like the theoretical, and no resistance or impedance-coupled amplifier served by a B battery eliminator will have it, unless the circuit is adequately and thoroughly filtered as illustrated.

Breaking Into Amateur Transmitting

(*Continued from page 322*)

graph, the key should be grasped lightly between the thumb, forefinger and middle finger; the other fingers take care of themselves. The round forearm muscle rests easily on the table; the whole arm is relaxed; motion is chiefly confined to the wrist and upper forearm. Another rule of sending, which could be adopted with benefit by many old timers. is: send slowly with regular spacing. Slow, even sending will get through a message much faster than a machine gun delivery which cannot be copied.

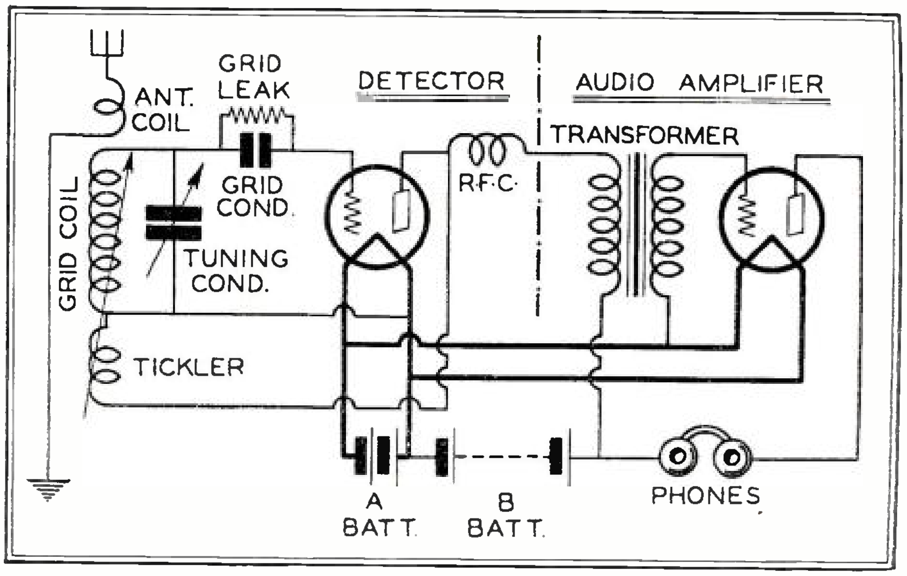


Fig. 4. Another requirement of the Government test is to draw the complete circuit details of your short-wave receiver

Licenses

As all radio activities are controlled locally by the Supervisor of Radio. applications for the required operators and station licenses must be made to him. The supervisors are stationed at Boston (1st district). New York (2nd). Baltimore (3rd), Atlanta (4th). New Orleans (5th). San Francisco (6th). Seattle (7th). Detroit (8th). and Chicago (9th). The district boundaries on the map (Figure 2) show at a glance which district you are in. You must make formal application in writing for each license. and for the operator's license pass a code test at ten words per minute and a short theoretical examination as well. This examination usually includes diagramming and explaining the operation of your transmitter and receiver (see Figs. 3 and 4). Other electrical queries are usually combined with a few questions about radio law—for instance: No operator may divulge the contents of private messages he may copy; no one shall send out a false distress signal: amateurs must stay within their allotted bands and observe evening and Sunday morning silent hours when their transmission would interfere with other services. The two types of licenses are illustrated in the photographs. Though the operator's license happens to be a 1st Class Commercial one, for which a 20 word code test and a theoretical examination lasting several hours are required, the general form and wording of an amateur license is the same.

When a first class receiver has been installed and when the operator is well on his (or her) way toward getting the necessary licenses. it will be time to think of building the transmitter. Here there may be a serious obstacle. usually human. in the form of a father, a wife. or perhaps some more distant yet equally insistent relative. The question arises: is it necessary to submerge everything else around the house in a maze of wiring before signals can be transmitted? The full answer to this question, fortunately negative. will take an article by itself, to appear next month under the title "A Short Wave Transmitter That Fits into the Home."

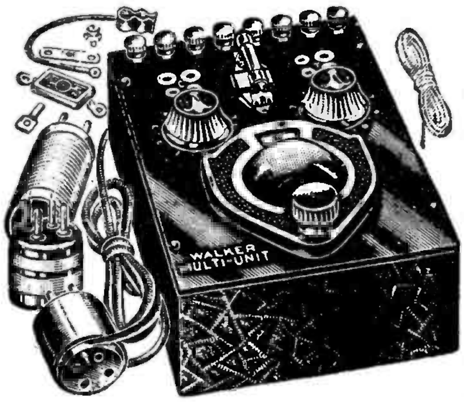
Radio News at the New York and Chicago Shows

To those of our readers who will attend either the New York or the Chicago radio shows, a cordial invitation is extended to make our booth their headquarters:

SIXTH ANNUAL RADIO WORLD'S FAIR, New Madison Square Garden, New York, September 23 to 28 inclusive, RADIO NEWS will occupy booth No. 2. Section II.

EIGHTH ANNUAL CHICAGO RADIO SHOW, Coliseum. Chicago. RADIO NEWS will occupy Booth No. 27. Section H H.

A Radio Utility and Entertainer



George W. Walker "MULTI-UNIT"

A Device with a Dozen Uses

SHORT WAVE RECEIVER — SHORT WAVE ADAPTER
REGULAR BROADCAST RECEIVER
SCREEN GRID PRE-AMPLIFIER — R. F. OSCILLATOR
EXTRA STAGE OF R. F. OR "BOOSTER"
RADIO "EXPERIMENTAL" UNIT
CRYSTAL RECEIVER — WAVE TRAP — WAVE METER

One of the most unusual radio instruments ever devised. Will perform any individual function of a complete receiver, and in addition may be used for calibrating, testing or checking. Makes a wonderful broadcast receiver, short wave receiver or transmitter. Oscillates violently over the entire scale range from 550 meters down to 15. Uses all tubes 199 to 210 and all voltages, A.C., D.C., or rectified. Nothing like it ever placed on the market before.

The Radio Fan has at his disposal a device which will provide him with something to tinker with for an entire season without performing the same experiment twice. Become acquainted with all the circuits and the way tubes perform under particular conditions.

The Dealer and the service man require this most valuable instrument for adjusting radio frequency circuits to resonance, providing a heat note or constant frequency oscillation for determining wave length of a particular condenser setting, calibrating a receiver disposing of trade-ins and obsolete sets by making them up to date by the addition of an R. F. amplifier.

NO ANTENNA-GROUND NEEDED

When using the Multi-Unit with most any receiver as an R. F. Booster (extra stage T. R. F.), the sensitivity increase is sufficient to make unnecessary the use of outside antenna. Tone quality is immediately improved. Less external electrical interference assured.

SHORT WAVE CONVERTER
(15-95 Meters)

Enjoy the novelty of short wave experiments by converting your present receiver to tune to the low waves. Utilizing the audio amplifier in your own receiver serves a dual purpose and increases volume and range. Plug the unit adapter into the detector socket of your set. No change in wiring or extra tube required. The Multi-Unit will function with either A. C. or D. C. receivers.

R. F. PRE-AMPLIFIER

Uses same type tube as in the R. F. stages of your present receiver. 199, 201-A, 222, 224, 226 or 227 tubes may be used. Either A. C. or D. C. Extreme selectivity, if you prefer. Tune in stations you never heard before. This efficient circuit reduces static and other interference. Greater clarity results as the additional volume makes over-loading of tube filaments unnecessary.

SCREEN GRID R. F. BOOSTER

Increase the range and volume of your present receiver to equal the latest Improved Screen Grid Receiver. Merely insert unit adapter plug in socket of your receiver. No change in receiver wiring. Adaptable to either A. C. or D. C. receivers.

SHORT WAVE RECEIVER
(15-95 Meters)

Experiment with the fascinating short waves. Tune to stations thousands of miles distant. Reception of short wave Foreign stations has been verified. Ideal all-year-around reception. Warm weather in Australia and New Zealand is winter in this country. Hundreds of short wave stations thruout the world are listed.

SINGLE TUBE RECEIVER

Ideal for either short wave or regular broadcast band.

SHORT WAVE R. F. BOOSTER

Connect the unit ahead of your short wave set and hear stations with greater volume. Uses screen grid or 201-A type tube.

R. F. OSCILLATOR

Check your receiver for wavelength and calibration. Determine resonance of circuits, test tubes for oscillation and regeneration, neutralizing receivers, balancing condensers, laboratory measurements, short distance transmission and generating a beat frequency for superheterodyne.

There are numerous additional uses, a few of which are wave meter, Loop R. F. Amplifier and growler for measuring efficiency of shielding material. By the time an experimenter has exhausted the possibilities of this instrument he will be qualified for a radio engineer.

Consists of the essential parts of an oscillatory circuit, and in addition are plug-in coils, adapter cord and plug, bridging connections, and extra wires along with well detailed instructions for many major experiments. Entire unit contained in box 7½ inches by 5 inches by 3½ inches. Price **$16.00**

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The Trade and Public of the two most important buying territories will be there.

ALL THE NEWEST DEVELOPMENTS!

The newest developments in radio, designed as a result of the many trends and ideas brought out at the June Trade Show will be on display. New models of receivers, speakers, tubes, furniture, prepared since June, will be among the displays of the 217 prominent exhibitors. The newest in TELEVISION will head the many feature attractions! See the evolution of radio: past, present and future.

It's the Roll Call of the Radio Industry! You cannot afford to miss it. PLAN NOW TO GO.

PARTS MATERIALS BUYING GUIDE!

This year, for the first time, both shows will include a Parts and Raw Materials Directory. With the official approval of the Radio Manufacturers Association it will be used as a buying guide by the industry's chief engineers, sales executives and purchasing agents. Every manufacturer who supplies material to the radio manufacturing industry should be represented.

RADIO MANUFACTURERS ASSOCIATION RMA

RADIO MANUFACTURERS' SHOW ASSOCIATION

G. CLAYTON IRWIN, Jr., *General Manager* — U. J. HERRMANN, *Managing Director*

(*Continued from page* 356)

tector tube socket and grid leak mount.

When you are satisfied that you have placed these parts in the correct position they may then be fastened down to the baseboard with woodscrews.

So much for the assembly of the parts.

Wiring the Audio Amplifier

To simplify the description of the wiring procedure, the transformer at the extreme right end of the baseboard will be referred to as Transformer No. 1; the socket to its left as Socket No. 1; the Amperite to its left, Amperite No. 1; the next transformer, Transformer No. 2; the socket to its left, Socket No. 2, and finally the Amperite to its left, Amperite No. 2.

The first step in the wiring job is to wire both grid circuits, then both plate circuits, then both filament circuits, and finally the B and C battery circuits.

First, connect a wire with the terminal marked "Grid" on Transformer No. 1 to the "G" terminal on Socket No. 1. Next connect a wire from the terminal marked "Grid" on Transformer No. 2 to the "G" terminal on Socket No. 2. Then connect a wire from the terminal marked "P" on Socket No. 1 to the terminal marked "Plate" on Transformer No. 2. Connect a wire from the terminal marked "P" on Socket No. 2 to the upper terminal of the Loud Speaker Jack mounted on the panel. Now unsolder the lead attached to the phone tip Fahnestock clip marked "P" and resolder it to the terminal marked "Plate" on Transformer No. 1. The wire connected to the other Fahnestock clip, marked "B plus," is next unsoldered, the clip removed, and the wire resoldered to the terminal marked "Pos. B" on Transformer No. 1. This latter wire is the one which leads to the Yellow terminal on the Cable Receptacle.

Now connect a wire from the "F plus" terminal of Socket No. 1 to the end of the Amperite No. 1 nearest the panel. Connect a wire from the "F plus" terminal on Socket No. 2 to the end of Amperite No. 2 nearest the panel. Next connect the free ends of both Amperites together and continue the connection to the Red terminal on the Connector Cable Receptacle. Then connect both "F minus" terminals of the sockets together and continue the connection to that side of the Filament Switch, mounted on the panel, to which is connected the wire leading to the "F minus" terminal on the detector socket. This particular switch terminal can be easily identified because it is the one that *does not* lead to the Black terminal on the Connector Cable Receptacle.

To complete the B battery circuits it is necessary to connect a wire from the terminal marked "Pos. B" on Transformer No. 2 to the Blue terminal on the Connector Cable Receptacle. Then connect a wire from the other vacant terminal on the Loud Speaker Jack to the Gray terminal of the Receptacle.

Now, the terminal on Transformer No. 1 marked "Neg. Fil." connects to the green terminal on the receptacle, while the similarly marked terminal on Transformer No. 2 connects to the brown terminal on the receptacle.

The grid and plate connections need take up only a small space between the units; in fact, the less space the better. The filament, B battery and C battery circuits, the latter connecting to the "Neg. Fil" terminals on the transformers may all be arranged neatly in cable formation along the rear edge of the baseboard. To keep these wires in place they may be bound with cord, but care should be exercised in this stage of the work to see that the cord does not cut the insulation covering the wire so as to cause possible short circuits.

Operation

After the wiring is completed the receiver is ready to operate as a three tube set. The signals will be loud enough to operate a loud speaker, and, when the proper values of B and C battery are used, as specified in Fig. 9, appearing in Lesson Number Two. (Radio News for September, 1929, Page 247), together with the correct vacuum tubes, a very fine tone quality of sound reproduction will result. In the first audio stage (Socket No. 1) a type 201A tube should be used. In the output stage (Socket No 2) a type 112A tube should be used.

To operate the receiver, assuming that all the batteries are connected to their proper wires, insert the amperites in their mounts, then insert the tubes in their respective sockets.

When the filament switch is turned on and a station tuned in, the music or speech will be many times louder than that heard in the phones with only the detector unit working. Since there are no variable features about the two-stage audio amplifier unit, no adjustment of it is required to keep it in satisfactory operation. Simply tune and operate the set as you did when you had only the detector unit.

Erratum Notice

In our September issue we published an article (p. 231), "Dr. Lee DeForest Writes the Reminiscences of a Radio Pioneer." There were several interesting illustrations, in that article, of some of Dr. DeForest's early experiments.

In view of the fact that the editor of *Radio Broadcast*, Mr. Willis K. Wing, was kind enough to lend those illustrations to us, we should have made the usual acknowledgment. Since this was omitted through an oversight, we take this opportunity of calling attention to the omission, acknowledging our obligation to *Radio Broadcast*, and sincerely apologizing to Mr. Wing.—THE EDITORS OF RADIO NEWS.

What Is a Good Loud Speaker?

(*Continued from page 319*)

are combined to produce a useful device.

A picture diagram showing the construction of an ordinary dynamic loud speaker is given in Fig. 3. The loud speaker consists of the following essential parts:

(a) the cone.
(b) the moving coil.
(c) the centering strips.
(d) the coupling transformer.
(e) the magnetic core.
(f) the field coils.

If one knows what to expect when examining a dynamic loud speaker, it is much easier to form some opinion regarding it. Let us examine in some detail the design, purpose and construction of the various sections listed above.

The Cone

The cone is usually made of a stiff paper formed into a conical shape so that maximum rigidity with a minimum of weight is obtained. The paper must be such that it does not alter in shape or size due to temperature variations and it must not be affected by dampness. The paper must not be subject to fatigue—these characteristics in the paper are essential if the loud speaker is to give long, useful service.

To energize the field coil of the dynamic, various power supplies are employed

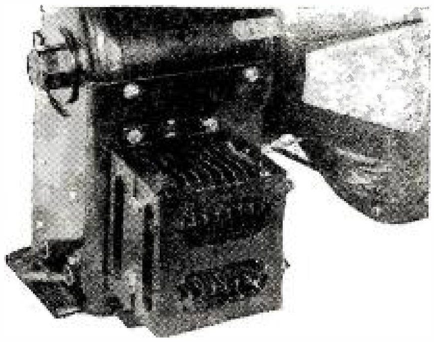
Until quite recently paper was the only material used in the construction of cones of any type. At present, however, the writer knows of one special material designed specially for use as a diaphragm material in dynamic loud speakers. It is known as Burtex and is used in a number of dynamic loud speakers. Its makers claim that it is unaffected by the weather and that a more efficient loud speaker with a somewhat better frequency response can be constructed by the use of Burtex. It's possible that there are some other special diaphragm materials on the market with which the writer is not familiar and which also have advantages over paper.

The angle at which the cone is formed is quite important. It determines the stiffness of the diaphragm and it also alters to some degree the frequency response characteristic of the loud speaker. The cone, small though it is, acts, at high frequencies, like a small horn. The larger the angle the smaller is the horn effect, but with large angles the cone is less rigid, which affects the efficiency and the low frequency response.

The cone is supported at the outer circumference by a strip of some soft, pliant material such as thin leather. It is essential that this supporting material be light and flexible so that it will not hinder the movements of the cone.

The Moving Coil

The position of the moving coil is clearly indicated in Fig. 3. The coil is generally wound on a support made of some thin insulating material which, in turn, is cemented fast to the paper cone. In the case of a diaphragm made of Burtex the support for the coil is part of the cone itself.



The dynamic shown here employs a stepped-down 110-volt line source rectified by the dry rectifier illustrated

The number of turns used for the moving coil may be anything from one up to several thousand. Generally, however, the coils consist of about one or two hundred turns of fine wire, about No. 35 gauge.

The coil and its support must move axilly to and fro in the air gap during operation of the loud speaker and it is therefore essential that the coil and its support be accurately centered in the air gap and that means be provided to maintain it in this position. In some models a thin spider web form is used for this purpose. Other dynamics make use of three light thin springs which serve to hold the moving coil accurately in the center of the gap and permit no movement sideways although permitting very free movement in the direction of the axis of the cone. The major requirement of the centering device is that it be stiff enough to accurately keep the coil centered but that it not interfere with the normal movements of the cone.

Some dynamics using light springs to center the coil also use these springs to convey the current to the moving coil. In other models current is supplied to the coil via two fine wires cemented along the cone.

The Coupling Transformer

The moving coil system of a dynamic loud speaker has, generally, quite a small electrical impedance. At low frequencies

(*Continued on page* 370)

(*Continued from page* 369)

the impedance of the average dynamic is something in the neighborhood of 10 to 25 ohms. If the loud speaker were ideal this impedance would be constant and of pure resistance at all frequencies. Actually the impedance of a moving coil speaker varies with the audio frequency, gradually increasing in value with increases in frequency.

At all audio frequencies the impedance of the average moving coil system is, however, much lower in value than the plate impedance of a power tube, and for this reason a coupling transformer must be used to adapt the impedance of the moving coil system to the plate impedance of the power tube. If we were to try and operate a dynamic loud speaker without any coupling transformer between the tube and the moving coil, we would find that the volume would be very low and that considerable distortion would be produced.

Coupling transformers as used in the ordinary dynamic loud speaker are generally designed to operate satisfactorily with any ordinary type of tube. In such cases somewhat increased efficiency would be obtained through the use of a special coupling transformer designed to operate satisfactorily with any ordinary type of tube. In such cases somewhat increased efficiency would be obtained through the use of a special coupling transformer designed to work with the particular tube to be used. At least one manufacturer, the Silver-Marshall Company, get around this problem very nicely by using a transformer with several taps on the primary so that the proper ratio for most efficient operation can be obtained no matter what power tubes or arrangement of power tubes the loud speaker might be supplied from.

The Iron Core and the Field Coils

The operation of a dynamic loud speaker depends upon the reaction of two magnetic fields, one due to the audio currents flowing through the moving coil and the other due to the currents flowing through the field coils. The currents flowing through the field winding set up a steady magnetic flux throughout the field circuit. The part of this flux which is useful is that part which passes across the air gap where the moving coil is located. It is at this point that the field flux reacts with the currents in the moving coil to cause the coil to move. The larger the audio currents through the moving coil and the greater the value of the steady flux due to the field, the greater the movement of the cone and therefore the greater the sound produced. It is of advantage therefore to get in the air gap as high a flux density as possible. Commercially, the loud speaker manufacturer designs the units for maximum flux density consistent with reasonable cost and a reasonable amount of power consumption from the source supplying the field power.

Power to supply the field may be obtained from a storage battery, from the filter system in a B power unit, or from the light socket. In the case where the light socket supplies a. c. the loud speaker is equipped with a rectifier so that d. c. is available for the field circuit.

This completes the technical discussion of the dynamic loud speaker. If it has accomplished what we hoped it would, the reader will have obtained from the preceding discussion a good idea of the relation of the various parts used in a dynamic loud speaker.

It is only when one has some idea of the general design, construction and purpose of the various parts of any device that one can properly compare one loud speaker with another. A man who goes into a radio store and says "I want a set" and then after listening to a half dozen decides to buy some particular one is very much like the traveler who goes on one of those "personally conducted" tours. He sees and hears what is shown to him—he never knows what he may be missing! The traveler—and the radio experimenter—who gets to know all the by paths is the one who gets off the beaten path and sets out for himself. He may bump his shins but in the end he has a good time and the satisfaction of having found out things for himself.

Building the Seven-Tube Magister Tuner

(Continued from page 308)

time they are clamped or pressed between two boards to remove the excess cement and to make them of uniform thickness. This thickness will be the same as the width of the bakelite rings.

After the slot wound coils are hard and dry, they are assembled on one inch diameter tubing three inch long. The tubing is split and a 1/8 inch section removed along its length. The coils may be easily slipped over the tubing by springing the one inch diameter tubing together. Two coils with their respective bakelite cores are slipped over the tubing as described above. Care should be exercised that the windings of both coils are in the same direction. This type of mounting permits adjustment of the coupling between coils, the slotted tubing springing outward and holding the coils in the adjusted position.

These band filter transformers are provided with lug terminals as also provided for the other coils described above. The bottom coil is used for the primary while the top coil is used as the secondary. The "outside" of the secondary coil connects to the grids of the tubes and is designated as "O." The "inside" of the secondary, designated "I," is connected to "B" minus. The "inside" of the primary "I" is connected to the plate while the "outside," designated "O," is connected to "B" plus 180 volts.

The antenna, oscillator, r. f., and band filter transformers are provided with brass or thick aluminum mounting brackets as shown in the detail sketch.

Making the Chassis

Seven feet of one inch angle brass 1/8 inch in thickness is used in the construction of the chassis frame. This material is cut to lengths of 29 inches and 10 inches respectively. Two of each are required. The ends of the angle brass are cut to a 45 degree angle on the surfaces to be used as the top of the frame. The iron corner pieces as mentioned in the list of parts (these are obtainable from any hardware store) are placed in proper position. The positions of the holes to be drilled and tapped for 8-32 screws are marked, after which the angle pieces are drilled and tapped. The ends of the angle pieces are butted together tightly and the resultant rectangular frame should have perfectly square corners as otherwise the chassis will be lop-sided. This construction is shown in detail in the drawings of Fig. 5. To further strengthen the frame the iron corner brace pieces are soldered to the brass angle pieces. An additional piece of flat metal is soldered to the under surface of the brass angle directly over the joint for better re-enforcement. This work results in a very strong frame and support which is greatly desirable for a receiver of these dimensions.

Assembly of Shield Compartments and Partitions

After the chassis frame has been made, a single sheet of aluminum 3-64 or 1-16 inch thick is cut to fit the top of the chassis frame. This serves as the bottom of the shield compartments as well as the common electrical connection when wiring the receiver.

The positions of the various slotted corner and partition posts holes are spotted, as shown in Fig. 5, on the bottom plate and drilled. The bottom plate is then placed in position on the chassis frame, the position of the holes marked on the frame which is in turn drilled. Care should be taken in spotting the position of the corner and partition posts, that they are square with the frame, as otherwise the shield compartments will be out of line.

The frame, bottom plate, corner and partition posts are now assembled together. This is accomplished by passing 6-32 machine screws through the holes of the chassis frame from the under side, through the holes in the bottom plate and screwed into the tapped holes at the ends of the posts. This makes a very neat and professional appearing assembly job.

The ten inch partitions are now slipped into place as shown in the picture diagram. Also the partition separating the i. f. compartments from the oscillator compartment. The inter-compartment partitions are now measured as to exact width, allowing 3/8 inch on each side for the turned over edges. It is wise to spot the positions of the fastening holes in these turned over edges and drill them before bending. After the inter-compartment partitions have been drilled, the turn overs are bent, trying not to warp the material any more than necessary in the bending process. These partitions are then placed in their respective positions, and the position of the holes in the turned over edges marked on the ten inch partitions, and drilled. This applies as well to the partition separating the first i. f. compartment from the drum dials and the partition separating the second i. f. from the power detector compartment. The three aluminum pieces for shielding of the band filter transformers from the chokes and screen-grid tube are now cut to size allowing 3/8 inch on each side for the turn over edges. These pieces are then bent into shape. When fastened into place these will make shield compartments 3 inches square.

Four of the ten inch partitions are also drilled for 1/2 inch holes to allow the passage of the condenser shafts thru each compartment to the drums.

Mounting Variable Condensers And Drums

The positions of the variable condensers are now marked on the bottom plate. To expedite matters it would be convenient to scribe the exact dimensions of each compartment on the bottom plate.

The type F drum dials are now placed in position. The projection on the bottom of the drum support frame is re-

On Short Waves

(Continued from page 352)

in phase with each other, the tickler coil is in the feedback position and will add to the resultant signal strength. The feedback from the plate circuit to the grid circuit is at radio frequencies, therefore, a by-pass condenser is connected from the lower side of the tickler to the filaments.

In Fig. 4 is shown another method for controlling regeneration. For short wave receivers, the action resulting from the use of this method is somewhat smoother than that shown in Fig. 3. The variable resister has a maximum resistance of 500,000 ohms and may either be connected in series, as indicated, or in shunt at the points marked X, X. When employing the variable resistance method for regeneration control, the secondary

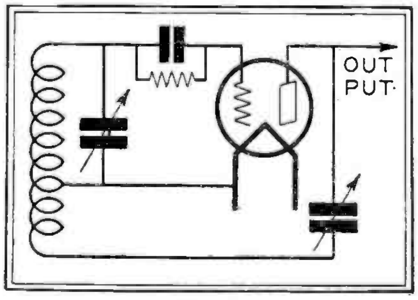


Fig. 6

and tickler coils are wound on the same form, a space usually separating the windings from each other about 1/4". Many variable factors enter into a calculation for the number of turns for a tickler. A general rule may be used, of a secondary and tickler turn ratio of 1 to 1 for the lowest wavelengths, increasing the secondary turns to 2 1/2 to 1 at 100 meters.

The method for controlling regeneration employed by a number of short-wave code receivers is shown in Figs. 5 and 6. Here a variable condenser is used as the regeneration control medium. In Fig. 5 a variable tickler is employed and after once being set need not be readjusted till such a time as some major change is made in the detector stage of the receiver. All feedback tuning is accomplished on the variable condenser. One precaution is necessary, being the connection of the rotor plates of the variable condenser to the tube filament circuit. In Fig. 6 the tickler is stationary, being wound on the same form as the secondary. The control condenser affords all necessary control of the feedback. Very little, if any, trouble will be experienced in either the variable resistor or the variable condenser regeneration in the logging of the grid turning circuit, as neither of these methods has the disadvantageous effect of that of the rotating tickler. Various other methods of providing regeneration may be used, such as the link circuit, variable split winding and plate variometer. These forms of controlling regeneration are not practical for short-wave receivers, so they will not be discussed here.

Experiment with the various systems outlined here will tend to illustrate each one's own peculiarities, advantages or disadvantages.

moved with a hacksaw. The drums are separated by a distance of approximately ½ inch, and each is mounted approximately 1¾ inches on center on each side of the center line of the chassis. This line is approximately 14½ inches from either end of the chassis. The positions of the holes in the drum support frame are marked and drilled thru the bottom plate and chassis frame. The drums are fastened to the chassis by screws placed through from beneath the chassis frame and bottom plate, and are then screwed into the tapped holes of the drum support frame.

The condensers are next mounted. A line is scribed along the length of the bottom plate to the same distance from the front edge of the chassis as that measured from the edge of the chassis to the center of the drum shaft sleeve. The positions of the holes in the cast aluminum frames of the condensers are marked on the above line. The condensers should be centered in the r. f. compartments, and the oscillator condenser should be placed approximately one inch from the partition separating the condenser from the drum dial compartment. Brass pillars of such height to center the condenser shafts with the drum shaft sleeve, are placed under the condenser frames. The condensers are now fastened solidly in place. After which the condenser shafts are placed through the condensers and drum dials.

Mounting the Coils

The various coils are now mounted in their proper positions in their various compartments. This work should be done before the shielding is assembled as it is more convenient to mount and wire the parts into the circuit as the shielding is assembled. This is especially true in respect to L3, L5, L6 and L7. The mica variable condensers for tuning the primaries and secondaries of the band filter circuits should also be mounted before mounting the band filter transformers.

The r. f. chokes are all mounted in the upright positions shown. Various positions or locations for these were tried before the positions as shown were found satisfactory.

Mounting of Additional Parts

The sockets are now mounted in position. In mounting these it is advisable to raise them from the bottom plate by washers ⅛ inch thick. This work will eliminate possible shorting of the prongs with the bottom plate, especially if the solder should happen to run down. It would also be advisable to raise the variodensers from the bottom in the same way. The author has learned to never invite trouble in this respect. The variodenser (C29) shunting the oscillator variable condenser (C4) is mounted near the variable condenser as shown. The purpose of the variodenser (C29) is to allow adjustment of the variable capacity, in relation to the inductance of the oscillator coil, to a scale reading nearly the same as the r. f. scale. Its use is not entirely necessary. Should the builder desire to eliminate it, the grid or secondary winding of the oscillator coupler should be increased from 55 to 60 turns. The 1 mfd. by-pass condenser (C28) is now mounted in the oscillator compartment in the position shown.

The power detector bias resistor is mounted in the detector compartment. The midget detector plate by-pass condenser (C26) is also mounted at this time.

The two volume controls (R7 and R8) are fastened to the front sections of the shield compartments as shown. The latter resistor must be insulated from the metal. The by-pass condensers with the exception of (C26) and (C28) are mounted underneath the bottom plate. The grid suppressors used as bias resistors (R1, R2, R3, R4, and R5) are soldered to one lug of their respective by-pass condensers (C11, C14, C17, C19 and C22) the other sides soldered to the brass frame. The exact values of the bias resistors depend upon the tubes on which there is a discussion in another paragraph.

The binding posts are now mounted, B1, B3, and B4 are insulated from the shielding. There are many ways of accomplishing this and therefore is not described here.

Wiring

In wiring the receiver it is advised that all high potential leads be wired first. This applies particularly to the grid and plate leads. These leads must be as direct and as short as possible. To further prevent feedbacks it is necessary to shield the grid circuit of each tube from its plate circuit as recommended by tube manufacturers. This is accomplished by using hollow metal braid, any of the various varieties on the radio market will prove satisfactory. The wire braid should of course be non-magnetic.

Beginning with the modulator, each compartment is wired completely, after which the partitions are fastened in place for that particular compartment. This procedure is carried out for each of the r. f. compartments. Beginning with the modulator compartment again, the i. f. transformers and their tuning condensers are wired, placing the shielding partition in permenent position after each is completed.

The balance of the wiring, composing the plate, screen grid "B" supply returns from their respective chokes, the negative and by-pass condenser returns are made in the order given. The a. c. supply for the tube heaters and the power switch are wire in last.

Preparing the Aluminum Cover

The cover for the aluminum compartments is made from a single sheet of aluminum 27¾ inches by 10 inches by 3-64 or 1-16 inch thick. The holes for fastening the cover to the corner and partition posts are spotted on the cover and drilled. The position of the tube port holes is marked and cut out with either a circular cutter or by scribing a circle in the proper position and drilling out with a succession of small holes drilled around the circumference, after which the small jagged edges are filed down with a round or half round file. The diameter of the port holes will be determined by the size of the port or caps. The author visited the 5 and 10 store and purchased seven of the large size aluminum shakers, the sort used by the kitchen help. These shakers had a diameter of 2¼ inches and were about the same height. A beaded rim or shoulder is found around the circumference about ⅝ inch from the bottom of the shaker. This raised shoulder served to prevent the cover from sliding through the port holes of the cover. The top portion of the shaker was removed to within ⅜ inch of the shoulder. It was also necessary to remove the end of the aluminum handle from the part of the shaker used as the cap. This was done by filing down the head of the aluminum rivet until the handle was loosened.

Tubes Used in the Receiver

Using the new speed 224 type tubes the bias resistors (R1, R2, R3, R4 and R5) must have a value of 750 ohms. This value of resistance is an odd size with most manufacturers but the value was easily obtainable by placing two 1400 ohm wire wound resistors of the grid suppressor type in parallel. If the old type 224 is used the value of the bias resistor must be 375 ohms for normal rated operation.

The Speed 227 type tube, of the quick action heater type, was found to be a very efficient oscillator when used in the "Magister" circuit.

Adjustment of the Receiver

When the wiring of the receiver has been completed, do not be afraid to test the receiver for shorts or other possible incorrect connections. When the builder has assured himself that the receiver is properly wired, the various power supply leads of the receiver are connected to the indicated voltages on the power supply unit. The antenna and ground are connected. A 250,000 ohm. resistance and one side of a 1 mfd., by-pass condenser are connected to the detector plate binding post. One terminal of a pair of phones is connected to the remaining side of the condenser. The remaining terminal of the phones may be connected to either the detector cathode binding post or to the remaining open end of the resistor. This end of the resistor is also temporarily supplied with from 135 to 180 volts from the power unit.

Provided the inductance of the r. f. secondaries are nearly the same, as well as the variable condensers (matched condensers in sets of three may be obtained from the manufacturer), no compensation of these stages will be necessary other than to set the condensers at their maximum capacities and tightening the rotors to the shafts by the set screws provided for that purpose. At this time the oscillator condenser shaft may be fastened and then both drums adjusted and tightened at their maximum scale indication.

The adjusting screws of the variodensers are now tightened (don't force the screw as this might break the device), after which each is loosened 1½ turns. The power switch, mounted on the volume control (R7) shaft is turned on. Each tube is inspected for heater action, a dim light should be noted. After a few seconds the r. f. drum is slowly rotated, meanwhile rotating the oscillator drum over a scale section of approximately 30 degrees. If the oscillator is functioning, all tubes perfect, a broadcast signal should be heard in the phones although the signal may be very weak.

If no signal is heard the oscillator tube should be observed for oscillation. This may be accomplished by inserting a pair of phones in the "B" plus return. Touching the grid and plate terminals of the socket with a wet finger tip, a plop should be heard on the placement and the removal of the finger will indicate oscillation, providing the action is observed on both the grid and plate. In rare cases it may be necessary to increase the number of turns in the plate coil of the oscillator coupler. The number of turns in this winding must always be kept as low as possible. In some cases the plate winding may be reversed and must be connected properly. If the coupler is contructed according to the detail drawing and to the description, there is no possible chance of the misconnection.

When the oscillator is functioning properly and a signal is heard in the phones connected in the plate circuit of the detector, the variodensers with the exception of C5 and C29, are adjusted for loudest signal. The coupling between the band filter transformer primaries and secondaries should be approximately 1¾ inches. If these coils have been properly matched no difficulty will be experienced in obtaining a definite resonant peak by the adjustment of the variodensers. By further adjusting the coupling between the coils the frequency of hand-pass may be obtained very effectively. It may be found necessary at this time to re-adjust (C5). If this condenser is re-adjusted it will become necessary to readjust the other variodensers again as described.

The variodenser (C29) shunting the oscillator variable condenser is now adjusted to bring the scale reading of both drums nearly the same. The builder is cautioned against rapid rotation of the tuning drums as it is very easy to pass over even the most powerful broadcast signal. When the receiver is in perfect working order the author hopes that the builder will obtain the same pleasure and develop the same enthusiasm, after pulling in station after station, DX and locals of various power, from one end of the tuning scale of the drums to the other. After proficiency of tuning is developed the builder will be able to pull in greater or Super-DX with ease. The author would be very glad to hear from "Magister" builders and owners. He will also endeavor to answer any questions concerning this receiver collectively through the medium of RADIO NEWS pages from time to time.

The Compact Flexible Speech Amplifier

(*Continued from page 328*)

ceiver through the switch JSN2 on the amplifier panel. If the filaments in the receiver are to be a. c. operated, a double pole. double throw snap switch should replace this switch, one side to be used for the bleeder circuit and the other for the 110 V. a. c. supply to the receiver filament transformer. The use of a storage battery for the r. f. filament is desirable in some cases where it is necessary to keep hum down to a minimum.

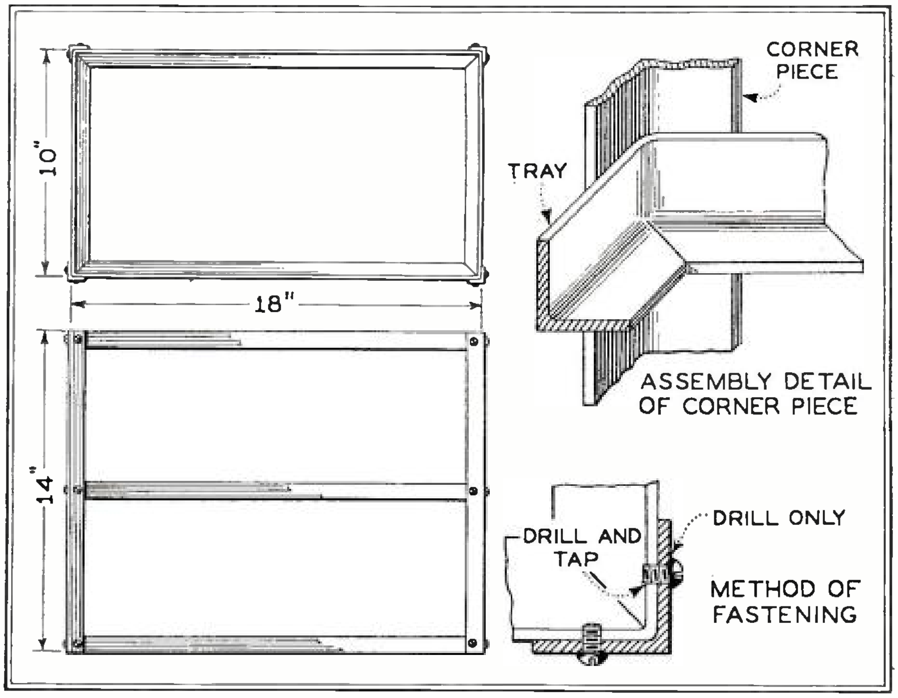
The resistence R1 in the power supply unit is equipped with semi-adjustable taps to provide any desired combination of plate voltages for the receiver. The output transformer incorporated in the amplifier is designed to feed into a dynamic speaker. A different type should be employed for use with magnetic speakers. Where two dynamic speakers are to be employed, it will be found best to connect them in series. In the case of magnetic speakers, if several are to be employed, they should be connected in series-parallel groups so that their total impedance will be equal to the impedance of a single speaker, or as nearly so as is possible.

There is no necessity for a verbal description of the construction of this amplifier. The very complete illustrations will provide all of the information necessary to an experienced constructor. However. some suggestions regarding the proper adjustment of the unit will be helpful.

Adjustment and Operation

Assuming that the construction and wiring have been completed, it is necessary that the taps on the output resistance network, R1, be adjusted before the assembly of the case has been completed. To make these adjustments the receiver. phonograph and the speaker should be connected up so that a complete operating test can be made. All tubes should be put in place in the receiver, and a 112A. a 350, and a 381 should be placed in their respective sockets in the amplifier unit. Then after making sure that the main control switch SW1 is turned to the "off" position, the amplifier may be plugged into the a. c. line. Next, the knobs controlling the C bias resistors R2 and R3 should be adjusted to their center positions and the milliammeter plug inserted in J2 ready to provide a reading of the plate current for the 350 tube. The receiver filaments may now be turned on in readiness for operation, and finally the main control switch SW1 may be turned on.

Immediately upon turning the amplifier on, the knob of the grid bias resistance for the 350 tube should be adjusted to show a plate current reading of 55 milliamperes. This immediate adjustment is made to avoid the possibility of damaging the tube by applying excessive current due to improper grid bias. The taps of resistor R1 are adjusted by first loosening the set screws and sliding the metal bands along the resistor unit. When in proper position they may be permanently fastened in place again. In order to make these adjustments a high resistance voltmeter is needed. This is first connected across the 135 volt tap and this tap adjusted to provide a 135 volt reading on the voltmeter. Then the other taps are similarly adjusted, one after the other, until the plate voltages

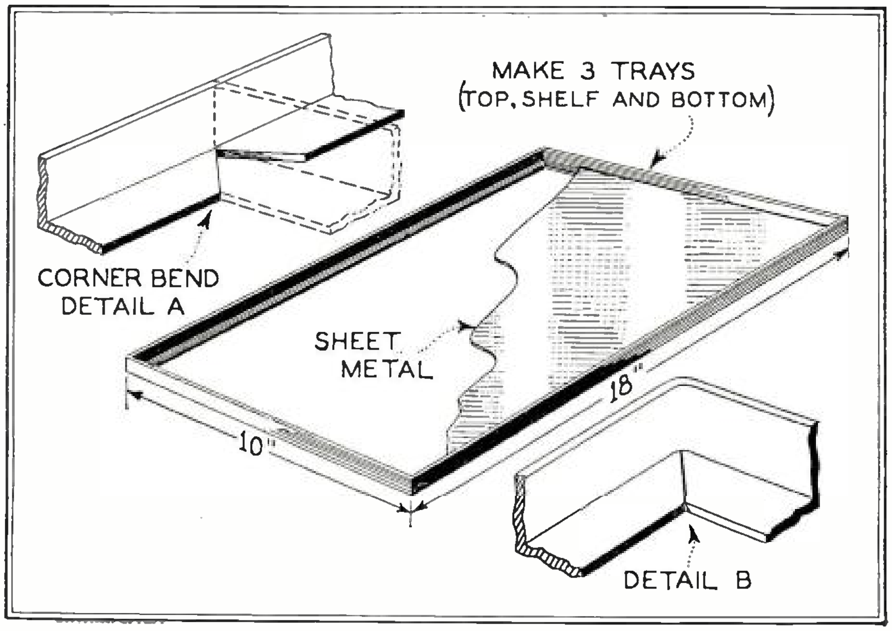


A sketch showing the framework of the amplifier required by the receiver and first stage audio tubes have been exactly adjusted. Next, connect the voltmeter across the resistor R2 and adjust the knob of this resistor until the meter shows a drop of nine volts, which is the bias required for the 112 tube with a plate voltage of 135. At this point it is advisable to again check the 135 volt tap to make sure that it has not been affected by the adjustment of the C bias.

The C bias for the power tube is measured by connecting the voltmeter directly across the portion of resistor R3 that is actually in the circuit. With the knob of this resistor adjusted to show a plate current of 55 milliamperes, the voltage reading across the biasing resistor should be very close to 84 volts. If at this current drain the bias voltage reading is 90 volts or higher, it is an indication that the 350 tube plate voltage (measured from the 350 tube filament center tap to the plate of this tube) is higher than the required 450 volts. Such excessive voltage may be the result of employing a receiver with very low plate current drain and may be corrected in one or two ways.

The first method is to connect a variable heavy duty resistance in series with which most of the receiver plate current is drawn. This will usually be the 90 volt tap, although in the case of a superheterodyne receiver it may be the 45 or 67 volt taps. If this resistance is left connected as shown in the schematic diagram, it will have a tendency to change the voltage on the plate of the first amplifier tube when the receiver is turned off but the amplifier left in operation. Inasmuch as this resistance is provided to compensate for receiver current drain, it is only logical that it be connected to the tap providing the greatest current to the receiver. The simplest method for adjusting this resistance to absorb the exact amount of current drawn by the receiver is to plug the milliammeter into J1 while the receiver is in operation. Note the milliammeter reading. Then turn off the receiver by means of the switch JSW2 and adjust the bleeder resistance until the milliammeter again shows the same current drain.

It may be desirable to arrange the complete installation in such a way that the main control switch SW1 of the amplifier will control not only the amplifier, but also the field supply to dynamic speakers and perhaps an a. c. supply to the receiver



A detailed drawing showing how the corners and frame for the trays are constructed

the high voltage side of the rectifier output between the rectifier and the first filter condenser, C3. This arrangement has the advantage that the excess voltage will not be applied to the filter condensers. However, a more convenient and quite satisfactory method of reducing the high voltage is to take the power tube plate supply off next to the highest tap of the resistor R1, moving this tap to provide the correct voltage.

The bleeder resistance, R5, is next adjusted. In the schematic diagram the high potential end of this resistor is shown connected to the high voltage output of the power supply. It may be found better to connect it to one of the lower voltage taps. The best one will depend on the plate current drawn by the receiver, and it should be the tap through unit. If so, it is only necessary to install standard outlet receptacles on the exterior of the amplifier case and supply these through the main switch. If an a. c. receiver is employed and a phonograph is also used, it will still be necessary to incorporate a switch (a. c. type) as indicated at JSW-2, in order that the receiver may be turned off when the phonograph is in use, thus avoiding undue wear on the receiver tubes.

This amplifier, when set up and put into use, should provide extremely satisfactory results. The tone quality will be exceptionally good and everything about the unit is calculated to provide a happy combination of truthful reproduction, freedom from breakdown, and flexibility of service. Simplicity of operation is another outstanding feature that will be appreciated by anyone for whom such an amplifier is installed. For readers who may desire to build higher power amplifiers, the foregoing descriptive matter will be most helpful because many of the ideas featured in the present amplifier may be successfully incorporated in others.

* * * * *

In the subsequent articles of this series descriptions of typical installations will be given, together with illustrations and diagrams. These descriptions will be of exceptional value to installation men. and to men entering this new field, because many of the technical problems encountered will be discussed—such, for instance, as the proper connections where several loud speakers are to operate from a single amplifier, types and methods of installation wiring, methods of volume control, etc.

LIST OF PARTS

5 Yaxley Pup jacks, No. 416—3, 4, 5, 6, 7.
2 Carter Imp short jack switches, No. 66—JSW1, JSW2.
1 Electrad Super Tonatrol (constant) type U—R4.
1 Electrad Truvolt, T10—R2.
1 Electrad Truvolt, T20—R3.
1 Electrad Truvolt, T500—R5.
2 Carter Short jacks closed circuit, No. 2A—J1, J2.
1 Carter "Tu Way" telephone jacks.
1 Weston Milliammeter, 0-100 MA, type 301—M.
1 Amertran DeLuxe first stage audio transformer—T1.
1 Amertran DeLuxe second stage audio transformer—T2.
1 Amertram output transformer, type 200—T3.
1 Amertran Equalizer transformer, No. 389-T4.
1 Afertran output transformer, type 200-T3.
8 Acme parvolt by-pass condensers, 1 mfd. 200 volt—C1, C2, C6, C7, C8, C9, C10, C12.
1 Acme Parvolt by-pass condenser, 4 mfd. 200 volt-C11.
2 Benjamin sockets, No. 9040.
1 Benjamin socket, No. 9036.
1 Roll Acme flexible twisted filament wire.
2 Rolls Acme 16-30 flexible Celastite 6-32" nuts and screws.
1 227 type tube-V1.
1 250 type tube-V2.
1 281 type tube-V3.
19 ft. Angle Iron, ½"x½".
2 Sheets Iron, 3-32"x18"x10".
Wire netting, 18" wide x 7 ft, ¼" mesh
1 Panel Bakelite, 7"x18".
1 Amertran power transformer, type P. F. 281-T5.
1 Electrad voltage divider, type 250 ("C Bias" resistor not used) -R1.
3 Acme Parvolt filter condensers, 2 mfd. 1000 volt - C3, C4, C5.
2 Amertran chokes, type 709 L1, L2.
1 4 Point line switch-2.
1 Carter Imp power switch, No. 110-1.
1 2-way porcelain receptacle block.
1 length lamp cord with plug.

INDEX TO ADVERTISERS

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

Building A 245 Power Amplifier

(*Continued from page 315*)

off the current to the receiver entirely.

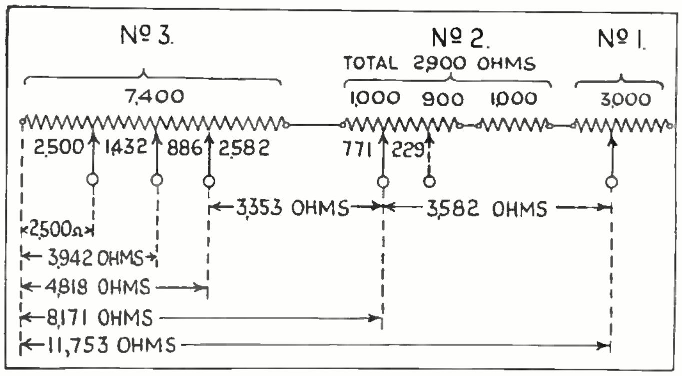
Connections of one unit to another within the console cabinet should be made by means of cabled leads, bunched together and bound with cord. Here, it is advisable to employ a color wiring so that in the case of error in connection, it will be easy to trace the wiring from one point to another.

It will be noted in Fig. 2 that an intermediate terminal board has been provided between the radio tuner unit and the audio amplifier-power supply so that connection of the plate voltage leads from the power supply to the tuner unit may be made first to the intermediate terminal board. This terminal board is employed so that if it is desired to change either the tuner or amplifier, this may be done without disturbing the connections to the other. A similar terminal board may be employed, if it is desired, to connect the leads from the jack switch, SJ, to the audio amplifier. Thus, any one of the units may be removed at will, without disturbing the remaining connections to the other unit.

It is well to remember that the 110 volt supply cord to the power transformer and to the filament transformer and phonograph motor should be placed in the cabinet so as not to be near the tuner unit. Otherwise a disagreeable hum will be picked up from the line and amplified accordingly, producing the most disagreeable hum in the loud speaker.

The design of the audio amplifier power supply device and the layout of the installation described here is offered to those desiring a suitable power supply unit housed, together with the tuner unit, in an acceptable type of console cabinet. Where the console to be used differs materially from the one illustrated, it will, of course, be up to the ingenuity of the constructor to arrange the location of the various units, so that not only will desirable, satisfactory results be obtained, but also a pleasing workmanlike appearance of the entire installation result.

Fig. 6. The Carter Resistor Kit No. 2314, consisting of three units, has its taps rearranged according to the circuit sketch shown at the right



Audio Amplifier—Power Supply Parts List

AUDIO AMPLIFIER:

One Thordarson audio transformer, type R400, T1.

One Thordarson input push-pull transformer, type 2922, T2.

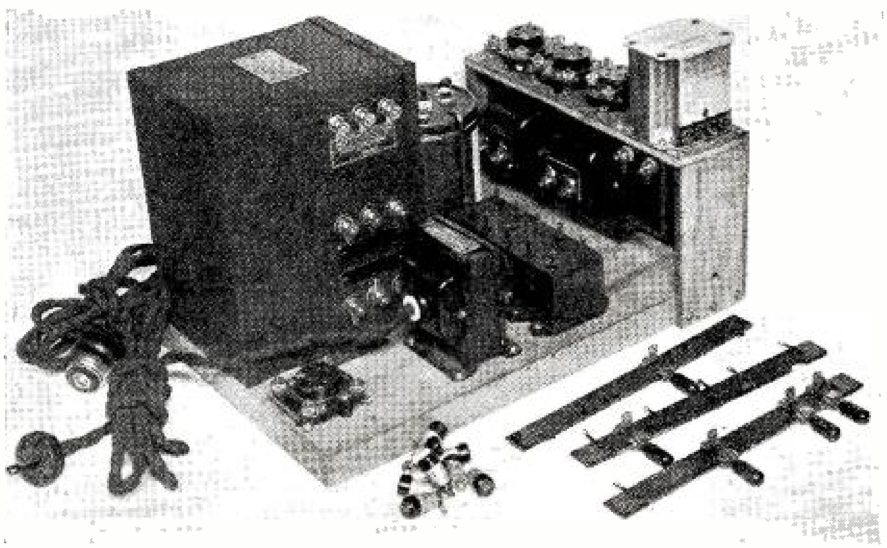
One Thordarson output push-pull transformer, type 2903, T3.

One Amertran equalizer transformer, No. 389, T4.

One Benjamin five-prong a. c. socket, No. 9036, V1.

Two Benjamin red top sockets, No. 9040, V2, V3.

(*Continued on page 383*)



A partly assembled view of the amplifier power supply device

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(Continued from page 381)

One Carter wire-wound grid resistor, type DH-1500, 1500 ohms, R6.
One Carter wire-wound grid resistor, type P-5-800, 800 ohms, R7.
One Carter center-tapped resistor, type CE-6, 6 ohms.
One Aerovox by-pass condenser, C1, 1 mfd.
One shelf with end pieces (as described).
One box Corwico Stranded Braidite.

POWER SUPPLY:

One Thordarson 245 power compact, type R245, T5.
One Mershon condenser bank, type T8, C2.
One Carter resistor kit, No. 2314, R1 to R5.
Four Aerovox by-pass condensers, 1 mfd., C3 to C6.
One Benjamin red top socket, No. 9040, V4.
One Thordarson filament transformer, No. 3660, T6.
One Panel, 7" x 9" (for voltage divider).
One Baseboard, 1" x 9" x 13½"
Two boxes Corwico Stranded Braidite.

MISCELLANEOUS:

One Electrad super-tonatrol, type U (phonograph volume control).
One Yaxley DP-DT jack switch, No. 60, SJ.
Eight Yaxley pup jacks, No. 416 (for L. S. and terminal board).
Two Boxes colored stranded Corwico Braidite.
Bakelite strip for terminal board.

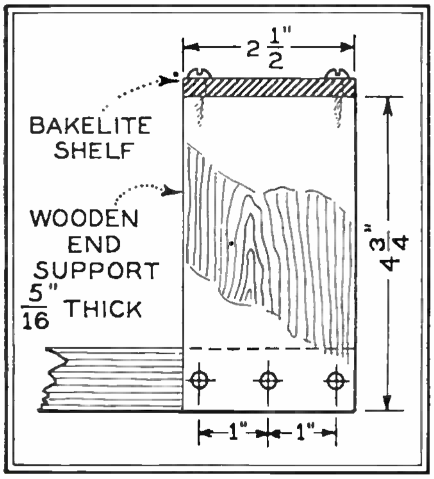

Fig. 5. Make two end pieces for supporting the shelf as shown here

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